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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Registered Office and Laboratories of the B.C.I.R.A. are at:—
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The B.C.I.R.A. Scottish Laboratories are:—
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Forthcoming Events.

DECEMBER 2.

Institute of Metals (Scottish Local Section):—Ordinary meeting at Glasgow. "Non-Ferrous Alloys used by Engineers," Paper by Wesley Lambert.

Institute of British Foundrymen.

NOVEMBER 28.

London Branch (Junior Section):—Ordinary meeting at 49, Wellington Street, London. "Foundry Practice," Paper by H. G. Summers.

DECEMBER 6.

Lancashire Branch:—Ordinary meeting at Manchester. "Foundries—and Foundries," Paper by S. H. Russell.

Scottish Branch:—Ordinary meeting at Glasgow. "The Production of an Aluminium-Alloy Casting," Paper by A. Harley. Also annual dinner.

West Riding of Yorkshire Branch:—Ordinary meeting at Bradford. "Some Aspects of Modern Foundry Practice," Paper by F. Griffiths.

The Heavy Oil Engine.

Something like a revolution is going on in the type of engine used for heavy road transport, like all the most effective revolutions, very quietly. The result may well be of vast importance to the foundry trade, for within five years the petrol engine for heavy road transport may become nothing more than a curiosity, and the tramcar may become obsolete.

Listen to the remarks made by an eminent tramways manager in the North. He said that an omnibus to-day ran about five miles for a gallon of petrol, costing a shilling. On crude oil they could run fifteen miles to the gallon at a cost of fivepence a gallon! Thus the running cost is cut in one stroke to a fifth. He said that experience had shown that people would willingly pay 50 per cent. more to travel in an omnibus than in a most modern type of high-speed tramcar, and conversion of tram routes to buses had resulted in large increases in passengers and in receipts. This city proposes to maintain a regular service between two points about ten miles apart entirely by omnibus.

The one weakness of the engine burning heavy oil is its weight, compared with the petrol engine. The task of the designer will be to bring down that weight just as he had to do in the aeroplane engine, almost regardless of cost. That tendency is bound to react on the foundry trade.

The L.G.O.C. is already applying for permission to put an oil-driven omnibus in passenger service. Trials of such a 'bus on the Great West Road were timed by the police, who warned the driver that he had been going over forty miles an hour. This engine works normally without magneto or sparking device. Suction draws air into the cylinder, and the air is then compressed to 500 lbs. per sq. in. Immediately before the end of the compression stroke liquid fuel is injected into the cylinder. The high air temperature created by the compression ignites the fuel oil, and the firing stroke takes place as in an ordinary motor engine, as does the exhaust. A starter is provided, together with an ignition system, to cover the warming up period on starting. The engine is controlled by varying the amount of fuel injected.

Prices, of course, are a matter of supply and demand, and if fuel oil is bought and petrol is a drug on the market the price of the latter will go down and the former will go up.

There is a movement on foot to cease calling these modern oil engines "Diesel" engines, not merely because modifications have been made to the original Diesel principle, but because, as the President of the Institution of Mechanical Engineers recently pointed out in his presidential address, the cycle was invented and used in this country before Diesel by an Englishman, Ackroyd-Stuart.

Foundry Problems.

Two branches of the Institute of British Foundrymen have conceived the idea of holding meetings or devoting a portion of a meeting to the discussion and possible resolution of problems of a practical character submitted by members or the firms with which they are associated. A meeting, held in Manchester recently, was not a great success, because of the sketchy nature of the wording of the problems submitted. In our position, we are often called upon for advice upon questions similar to those placed before the meetings, and we usually arrive at the conclusion reached at Manchester—that lack of detailed information can only result in the reiteration of well-known basic principles.

Sometimes further correspondence elicits a certain amount of additional information, but for many foundries, we must confess, there is a great lack of precise recorded information about process details. Years ago we stated in this column that if a question is logically posed it is virtually answered. Take, for example, a question actually submitted. Which is the best way to run pipes which have to withstand pressure? Primarily one asks in what metal. The answer is "cast iron." This is followed by maybe the following series of questions and answers:—What sort of cast iron? Why grey? Why the composition cited? Why a long cooling range? This series being answered one knows a considerable amount of the metallurgy of the metal used. Then a start can be made with the details of the pipes themselves, and finally the meaning of "running" is entered into, which will involve the nature and condition of the mould material. We feel reasonably certain that when the inquirer had furnished all the data necessary to have a reasonably-logical answer to his question, he would be in a position to furnish the solution himself.

The excellent results achieved by some of the processes recently installed in iron foundries are due in no small measure to the fact that they require close scientific control for their operation. The answers to the majority of questions likely to be posed at Institute meetings will only be resolvable—luck excepted—when scientific control of foundry practice is general throughout the country. The solution of the hot spot problem, due to internal cores cooling too slowly, will have to be met by the use of material of higher thermal conductivity than the balance of the mould material. Metallic chills may not always be allowed, and some mixture incorporating metallic shot, or perhaps heavy oxides which do not evolve gas, may be the ultimate solution.

XUM

Aluminium Gives Way.

By "Onlooker."

After a prolonged and stubborn fight against the downward trend of metal values, aluminium has at last been compelled to fall into line with the prevailing fashion and accept a reduction in value. That such a course was inevitable nobody could doubt, but some surprise may be permitted that the cut was as much as £10, although at the same time this is not out of the way when compared with a fall of nearly £40 in copper and £65 in tin. On the whole it must be admitted that the aluminium people have done well in holding up the quotation for as long as they have.

Had a decision been left to the British interests it is doubtful if any reduction would have been seen, for the tragic example of copper is much in evidence to point the truth that price cutting does not necessarily stimulate buying. Apparently the German section of the trade has found things very bad, and was extremely anxious to try out the effect of a reduction in the price, so that one must presume there was little choice left but to agree if a united front were to be preserved. For some time past there has been evidence that conditions in the German aluminium trade were far from good, for parcels of remelted ingot and scrap have been pressed for sale in this country at prices which were decidedly cheap by comparison with virgin.

Although officially denied up to the eleventh hour by producers, the cut in the selling price of aluminium was expected by consumers here, who have for some months been confining themselves to a policy of hand-to-mouth purchasing. Stocks in their hands are therefore not likely to be heavy, but whether they will now be tempted to secure forward cover remains to be seen. There have even been rumours of a rise in the price, but with copper slipping away almost daily and the other non-ferrous metals none too strong, it seems hard to believe that the aluminium quotation will be advanced again this year. The suggestion probably arises from the fact that wire bars have been put back to £95, but should big tonnage inquiries for electrical work again appear on the market this price would probably come back to £85 if only temporarily.

As to the reasons which have prompted the belated reduction in aluminium values, one suggestion is put forward that the cut was intended as a gesture to the motor-car industry at a time when the annual show was in full swing. This may or may not be true, but it is very doubtful if any cut would have been made had not other metals made the pace so hot that in sheer self-preservation aluminium was compelled to follow. This point is especially prominent in considering the electrical industry, and particularly the power installations which are making use of iron-cored aluminium cable to a very considerable extent. With the price of electrolytic copper wire bars down to just half that of their lighter rival, it is not surprising that the friends of the latter should take alarm.

Aluminium is a metal which has advanced much in popularity during the years since the war, and its use is always being extended, but to hold up the price against the natural urge of economic forces would be to commit the error perpetrated by the copper combine in maintaining their product at £84 long after it had ceased to be attractive to users at that level. If a stitch in time saves nine, then it may well be that this £10 off aluminium is going to save a lot of money later on, and a lot of trouble, too.

The public examination of Mr. Frank Shaw, carrying on business at Ghyllroyd Foundry, Guiseley, ironfounder, will take place at the County Court House, Albion Place, Leeds, on December 16.

London Foundrymen Discuss American Practice.

On November 13, Mr. J. G. Pearce, M.Sc., M.I.E.E., Director of the British Cast Iron Research Association, gave a lecture to the London Branch of the Institute of British Foundrymen on foundry practice and theory in the United States, at the Edibell Demonstration Theatre, Wardour Street. Mr. A. F. Gibbs, Branch-President, was in the chair. The lecturer conveyed the thanks to the Institute of British Foundrymen of many members of the party which visited England for the London Convention of 1929 and particularly those who attended the pre-Convention tour. He then dealt with recent developments in American foundry practice, particularly in connection with cupola melting, moulding sands and high-duty irons.

The President opened what proved to be an excellent discussion, and a vote of thanks was proposed by Mr. H. C. Dews, seconded by Mr. Hands, and carried with acclamation.

Burnley Foundrymen Meet.

The second meeting of the Burnley Section of the Lancashire Branch of the Institute of British Foundrymen was held at the Technical College, Burnley, on November 11, 1930. Mr. A. Jackson, President of the Burnley Section, presided. A good audience was present; amongst others, Mr. Howarth and Mr. Blackledge, President and Secretary respectively of the Burnley Branch of the National Union of Foundry Workers, and several of their members.

Mr. R. W. Stubbs' remarks were intended specially to interest those members of the Union who are not already members of the Institute of British Foundrymen. In the course of his Paper he made a logical survey of the value of technical societies, stressing their importance as bureaux of information, social centres and educational agencies. Their far-reaching influence in establishing for the industry a scientific *raison d'être* was clearly shown. Activities such as juvenile instruction, educational standardisation and specialisation, materials specification, research encouragement, were all detailed.

A vote of thanks was accorded Mr. Stubbs for his very able address, supported by remarks from Mr. Jackson, Mr. Hogg, Mr. Meadowcroft and Mr. Howarth.

The New Light-Castings Association.

In a recent leading article we indicated that movements were on foot to form certain employers' federations within the foundry industry. One has now become *un fait accompli*. A new association has been formed to replace the old National Light-Castings Association under the presidency of Sir Gervais Rentoul, K.C., M.P. The director is Mr. W. R. Blair, who for many years acted as assistant to Bailie King, whilst Mr. Sneddon is to be the secretary. The first committee will be composed of the executive committee of the organising body together with the executive committee of the old N.L.C.A.

The businesses of Messrs. Rabone Bros. & Company, 297, Broad Street, Birmingham, and Messrs. Th. W. Petersen & Company, Limited, 26, Newhall Hill, Birmingham, merchant exporters of iron and steel, etc., are to be amalgamated. A new company has been formed, under the title of Rabone, Petersen & Company, Limited, with a nominal capital of £200,000.

Random Shots.

It would be unwise to take too literally the reports from some quarters regarding the alleged failure of the Imperial Conference. The Conference has offered opportunities of direct contact between our experts and those from the overseas Dominions, and these are likely to have a very real and definite value.

* * *

An instance is quoted in a report on Empire standardisation. A bridge, designed in England, is being erected to span the river Hooghly, near Calcutta. It is being erected by the Indian branch of a British steel firm. The bridge spans alone take over sixteen thousand tons of steel, and the whole of it is being produced to B.E.S.A. standards. Sixty per cent. is being made in India from native ore and with Indian labour, while the remaining 40 per cent. is being made in this country.

* * *

Thus sections rolled over seven thousand miles apart are being required to assemble, and are being assembled, without difficulty on the site. Engineers, of course, do not see anything out of the ordinary in this, but it is the kind of illustration that catches the public imagination, and conveys an understanding of the necessity for and significance of standardisation. And that is all to the good.

* * *

There seems to be a good deal more excitement about the present Association football season than usual. Football has always been a speciality of the industrial north, the hard-working, hard-headed areas of Lancashire and Yorkshire. And a London team, a team from the soft and lazy south, Arsenal, to wit, is showing them all how to do it.

* * *

And there are other matters. Why, for instance, it is asked, does the B.B.C., with a snobbish preference for the minor sports and Rugby, give all these results first, when the teeming millions ache for the Association results, and perhaps even the names of the racing winners? And why doesn't the Association agree to First League matches being broadcast? And hasn't the popularity and success of the Arsenal something to do with the fact that alone among the League clubs they are willing to arrange broadcast commentaries? I ask you?

* * *

Public opinion in this country is a weird and wonderful thing. Never did it express itself so emphatically as when the Football Association refused to allow the Cup Tie final at Wembley to be broadcast last April. And never did a responsible body climb down so quickly as on that occasion. A similar expression would soon arrange matters. Nowadays, the advice given to people should be not "Write to your M.P. about it," but "Write to your newspaper about it."

* * *

The B.B.C. is usually right in these matters, but it has such a painfully Oxford way of being right that it leaves us even more irritated than if it were occasionally wrong.

* * *

Good advice is what old men give young men when they can no longer set them a bad example.

Marksman.

Nickel in Cast Iron.

"Nickel in Cast Iron" was the subject of an interesting address given to the members of the Wales, Monmouth and West of England Branch of the Institute of British Foundrymen, at the University College, Cardiff, on November 8, 1930.

The lecturer was Mr. W. T. Griffiths, M.Sc., of London, who said that the idea of using nickel in cast iron was not a new one, and pointed out that over 100 years ago patents had been taken out claiming the beneficial effect of nickel in preventing oxidation and rusting. He next reviewed the various researches which had been carried out, referring specially to the work of Professor Guillet in France, Wickenden and Vanick in America, and Hanson and Everest in this country.

Before dealing with the effect of nickel, consideration was given to the structure of ordinary cast irons. By means of slides the way in which thin sections showed white or mottled structures and thick sections grey and sometimes open structures was demonstrated. The effect of silicon in graphitising the carbon, in preventing chill in the thin sections and in opening the grain of the thicker sections was mentioned.

Nickel acted in the same way as silicon in regard to graphitising, but differed from this element in that its graphitising effect was not so intense, while it had further important effects on the matrix of the iron. By means of a series of illustrations the effect of increasing additions of nickel was shown, both on the structure and mechanical properties of the iron. It was also shown that nickel could be used for avoiding chill in the thin sections of a casting without the thicker sections becoming open and porous. Indeed, the effect of the nickel was first of all to put up the strength of the grey portions of the casting.

The result of this combined effect of greying the thin sections and of strengthening the thick was to make the iron much more uniform, thus allowing difficult castings of high quality to be made with ease. Emphasis was laid on the necessity of lowering the silicon content when adding nickel if optimum results were to be obtained. Thus silicon should be lowered by about 0.3 per cent. for every 1 per cent. of nickel added. Several instances of castings were given to illustrate the beneficial effect of nickel additions.

Ameliorating Porosity.

The lecturer then went on to show how nickel by its densening effect was being used to avoid porosity in castings where all trace of this trouble had to be avoided. By reference to castings in petrol pump bodies, ammonia compressing machinery, type-setting machines and others, the effect of nickel in this connection was illustrated.

The addition of chromium, together with nickel, was then discussed. It was shown that chromium tended to chill the iron and make it unmachinable, while nickel acted in the opposite direction. Thus by adding nickel and chromium together in the proper proportions a strong wear-resisting but machinable iron was obtained. Illustrations were given of the use of nickel-chromium cast iron for automobile cylinder blocks, pistons and cylinder liners.

A Wear-Resisting Alloy.

One of the recent developments in regard to nickel additions to cast iron was its use alone and with chromium for producing very hard wear-resisting material. This was obtained by air- or oil-hardening cast iron containing some 3½ per cent. nickel and up to 1 per cent. chromium, or by adding 5 to 6 per cent. nickel alone to a suitable iron, the latter then being in the hardened condition when taken from the sand. In these irons one had graphite embedded in what was really a hardened steel, and very good wear-resisting properties had been obtained from this material.

Nickel and chromium additions were also being made to chilled white irons in order to get very hard surfaces backed up by a comparatively strong and tough core, and these alloyed white irons were being used for such purposes as crusher jaws, chilled rolls, etc. Reference was also made to the use of nickel in heat-resisting irons and also to the oxidation and corrosion-resisting properties of austenitic cast irons produced by adding about 15 per cent. nickel together with copper and a small amount of chromium. Finally some suggestions as to the methods of adding nickel were made, together with a reference to the various forms in which nickel was available.

In conclusion, the lecturer said that, as in most matters of the kind, it was not only a question of adding nickel, but also adding a little common sense at the same time. When the addition was judiciously made, worthwhile results were certainly obtainable.

DISCUSSION.

Mr. J. J. McClelland said it seemed quite clear as to how to add nickel, but the problem was how to apply it to the metal one had to use. Could Mr. Griffiths give a ruling so that if, for example, one was making a coupling with a heavy boss and a rather thin rim and also wishing to cast a cylinder lining and piston heads and, having no laboratory, one could not find out what the percentage of silicon was? The mixture would possibly be 25 per cent. pig-iron to 75 per cent. good machinery scrap. What would be the percentage of nickel to be added for the type of castings mentioned?

Mr. Griffiths said that it was certainly a handicap in using nickel not to know something about the composition of one's metal. If one could not have an analysis it was naturally a case of trial and error and, in making experiments, the principles that he had tried to elaborate in his address should be employed. Thus, if the iron run for the majority of jobs was on the open side, it would be necessary before adding the nickel to make it closer, either by adding the closest pig available or utilising a steel addition. Alternatively, if one was troubled with chilling in some sections of certain castings it was possible that nickel could be used directly in the iron in question. Naturally each job had to be discussed on its own merits, but one could experiment first of all with nickel additions of about 1 per cent. One to 1½ per cent. nickel would, in general, give one what one wanted, except in very thin sections, when 2 or more per cent. may sometimes be employed, of course with suitable reductions of silicon.

Mr. R. J. Richardson asked what would be the increased cost per cwt., and was informed that this would be about 2s.

A Defective Casting.

Mr. J. Bennett said his firm were making small liners for a firm who insisted upon very high-class work. They had been using pure nickel shot, but at the suggestion of the Mond Nickel Company they had tried some "F" nickel. However, they had not, as yet, been able to produce a successful liner, although conditions seemed to be ideal with a good hot metal, a cylinder-iron mixture and nickel added in the way described by Mr. Griffiths. When the castings were machined they showed dirty patches. A specimen was displayed for inspection. The same liner without the addition of nickel machined up perfectly, but the specification called for the inclusion of nickel.

Mr. Griffiths said it was not obvious from the casting what the dirty patches were. It might be uneven distribution of nickel, although it certainly did not look like it. If it were, there must be some factor in the method of addition, the temperature of the iron or the method of casting which might be modified, since it was a fact that liners of similar composition to that mentioned were being made successfully. Certainly 2 per cent. of nickel might not be easily introduced into a casting of the type shown unless care was used. If the trouble was chilling of the iron, he suggested that warming the "F" nickel shot might help matters. Some people, indeed, melt nickel before they add it to cast iron, especially when making additions of 3 per cent. or over. Problems such as this were best discussed in the foundry, with all the details in front of one, and he would be very glad to discuss the subject in that way later if Mr. Bennett thought it would be of any assistance.

Crankcase Castings.

Mr. I. Rees, of Bristol, said that when making crankcase castings to Air Board Specification K6, 3 per cent. nickel was called for. Was not this rather high?

Mr. Griffiths answered that he would consider this a high addition unless the sections of the casting in question were particularly thin.

Mr. Rees said that he had had experience of placing the nickel shot at the bottom of the ladle and pouring the iron on it. He could confirm what Mr. Griffiths said that when one did this trouble in regard to poor mixing of the nickel with the iron was obtained. Of course, the same effect was met with when one made similar mistakes with ferro-silicon.

A short discussion then took place on the reasons for the occurrence of porosity, and Mr. Griffiths emphasised the difficulty of getting a test which would demonstrate the effect of any element on the reduction or elimination of porosity.

Waster Saving.

Mr. Rees said that when casting pistons 5 in. in diameter of very light section with a wall only $\frac{1}{16}$ in. and fairly heavy bosses, he could not overcome the porosity in the bosses which cracked when finished. By adding 1 per cent. nickel the work turned out satisfactorily. The point is always to save as much trouble as possible.

Mr. Griffiths said that the point about nickel was that it enabled one to do a job one could not otherwise do, and the fact that it was being used so much was due to the fact that people were balancing its initial cost against the saving on wasters.

Mr. B. Hird said the trouble was that customers wanted a better job at a lower cost, and the founders' prices were cut down.

Mr. Griffiths said it was partly a question of educating the engineers, although some founders found it paid them to use nickel and make no extra charge. They saved on wasters. In some cases one would get 50 per cent. wasters because the engineers had produced a design which was difficult.

Mr. W. R. D. Jones said that in casting liners one would get a great deal of scrap. What would be the effect of remelting?

Mr. Griffiths said that nickel did not oxidise in the presence of iron and, therefore, could be remelted time and time again without loss.

General Co-operation.

Mr. J. P. Galletly suggested that it was not so much a question of educating the engineer as educating the commercial man.

Mr. Griffiths thought it very difficult to draw the line, but there was a great deal of room for educating the purchasing agents. There is a greater sense of the possibility of saving a little by paying more than there used to be. Engineering firms are demanding things of metals that they would not have dreamt of doing 10 to 15 years ago, and are beginning to see light. They are willing to pay more. At the

(*Concluded on page* 370.)

D

Casting a Brake Wheel.

SCOTTISH FOUNDERS INAUGURATE PRACTICAL DISCUSSIONS.

In our last issue we reported that the Council of the Scottish Branch of the Institute of British Foundrymen had decided to reserve at the end of each meeting, following the presentation and discussion of the Paper or lecture, a short time wherein members could discuss the various foundry problems encountered from time to time in the course of their daily work. It was thought that thereby the value of the Branch meetings would be greatly enhanced.

A Defective Brake Wheel.

The Branch-President (Mr. J. Miller) inaugurated this innovation at the conclusion of the discussion on Mr. R. Liddle's Paper on "The Moulding and Casting of Bronze Plates," which appears elsewhere in this issue. He said that a problem which had presented itself to him was that he was asked to cast a brake wheel in a great hurry for a breakdown job. Fig. A showed the general outline of the wheel and the manner in which they cast it. There were two down-gates on the rim and one flower on the boss. The boss was chilled. Examining the wheel after it was cast, they noticed that there was a slight cavity under the flower but assumed that it was all right and sent the casting to the machine shop, but when the skin was taken off it was found that there was a rather large cavity and the casting was scrapped. They held the usual *post-mortem* examination, and one foreman said it was a draw and another was doubtful. He himself decided that it was not a draw, because in the cavity were two blobs like hens' eggs, and to his mind it appeared that the trouble was due to an accumulation of gas which had been trapped and covered with a thin skin of metal. He proposed to leave the matter there for their consideration and would be interested to hear the views of any members who had had a similar experience.

Mr. J. Longden asked for the full dimensions of the casting.

The President said the wheel was 2 ft. 6 in. outside diameter with a face of about 6 in. The rim was 1¼ in. finished, $\frac{5}{16}$ in. being allowed for machining.

Use of Chills.

Mr. J. Longden: Was the chill a solid iron core? Had the chill been used before?

Mr. Miller: The chill was a solid iron core, and he believed that it had been used previously, but he was not sure. As a matter of fact, they had a long discussion on that point after the wheel was scrapped.

Mr. J. Longden said that it was certainly not safe to use a chill more than once or at the most twice, because it became coated with a deposit of oxide where it came into contact with the metal. That deposit of oxide could not be removed even by grinding. Where the metal came into contact with the chill there was a considerable amount of gas formed, probably carbon monoxide or even carbon dioxide. He had seen on many occasions gas cavities in castings in the region of old chills. He had had a fairly large experience of the use of chills and had made a large number of castings in iron chills in a foundry where they blow from 8 a.m. to 5 p.m. After a set of chills had been used for a certain time on any given day the castings came out with blowholes due to the CO formed. He thought, with the chairman, that the defect in the wheel was not due to drawing, but to gas.

A Member said that he used chills very extensively, and found that he got blowholes if the chills were used repeatedly, due to the skin of oxide which collected on them. This happened even if the chill were buffed. He found that if he put on a good feeder it helped matters considerably.

Mr. T. Bell said that he would like to say something about chill moulds, which were in operation year in and year out. He had never experienced any trouble with blowholes or cavities in the castings which were not machined but ground, and he thought that if Mr. Longden suggested was true about the formation of gas, some evidence of it should be found in the grinding. He had a long experience in the casting of chilled car wheels and rolls, as they knew a new mould was not made for each wheel or roll. It seemed to him that the problem which the President had put to them was not to be solved by the gas theory, but he rather thought it was a case of phosphide separating. He believed the solution would be better obtained from a consideration of the composition of the metal. He had made thousands of car wheels from one mould without having the slightest trouble. The thickness of these wheel rims was no more than that in the one under discussion, with a thickness of 3 in. in the boss.

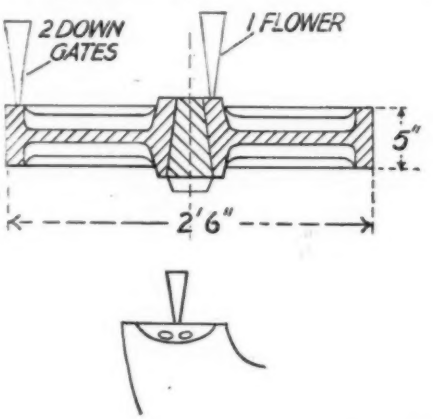

Fig. A.—Manner in which the Brake Wheel was Cast.

Mr. Longden: In the case of car-wheel rims, would Mr. Bell say if they were treated in any way?

Mr. Bell: Yes, we had to paint them, the same with the roll moulds.

Mr. Longden: That puts quite a different complexion on the matter. The paint protected the chill.

Phosphorus Theory Discounted.

Mr. Lawrie said that the case put before them by the President was an interesting one, and he did not know if he could give the solution. In the ordinary way he would have said that it was a drawn hole, but drawn holes were ragged, which the President had assured them was not the case with that one. In that case there were also the two pellets, which Mr. Bell thought were due to the composition of the metal. He was rather dubious about suggesting phosphorus, although the pellets looked like it, because on one occasion when the formation of a peculiar lump on the corner of an ingot mould was under discussion, his suggestion of a phosphorus segregation was pooh poohed, and he was told that there was hardly any phosphorus in the metal as it was hematite. In the case being discussed, it occurred to him that if the trouble was due to phosphorus, what was it that formed the cavity, as there must have been a cavity for the phosphide to drop into? He thought that the cavity was due to gas from the oil and that it would have been overcome if the flower had been in that vicinity. He knew that gas was formed by the action of metal on chills. In the case of loam-moulders' rings, the first one was always sound, the next one or two had blowholes, and the holes got bigger in each succeeding ring. There was evidence of oxidation, which accounted for the blowholes.

Wheel Cast without Flower.

The President: The discussion had been very interesting, and he had listened with much pleasure to the remarks of the various speakers. He was interested to note that one or two points had been mentioned during the discussion which had occurred to him when considering the best manner of getting out of the trouble, especially in regard to the formation of blowholes and the use of a flower. His first impression on seeing the cavity was that the metal had been running rather "dull," but he theorised that, with only one flower on the mould, there had been an accumulation of gas and as the metal rose in the mould that gas tried to escape. It would naturally make for the easiest way out, which was to the flower. He, therefore, decided to cut out the flower in the replace casting and put on extra gates. The moulder who had the job to make was very dubious, and almost refused to make the mould without a flower until he had been relieved of all responsibility. The job was cast with six down-gates around the rim and without a flower. The casting turned out splendidly. He had not yet decided the life of the chills, but he had cast several wheels since in the same manner without any troubles. The moulder afterwards told him the method worked all right. He was not sure whether his theory was right or wrong, but, at any rate, he had surmounted the difficulty.

He thanked all who had contributed to the discussion, and hoped that any one meeting with problems in the daily round would state them at the meetings so that a practical discussion could take place.

Nickel in Cast Iron.

(*Concluded from page* 369.)

same time by the use of nickel founders had been able to retain jobs they would otherwise have lost. One man in the States had informed him that the use of nickel had just saved him from going out of business, for he had reached the stage when he could no longer meet the requirements of his customers. In America they were, of course, in a much worse position than ourselves from the point of view of the supply of pig-iron.

Vote of Thanks.

In proposing a vote of thanks to Mr. Griffiths, Mr. W. Williams said, although a non-ferrous founder, he had found the lecture very interesting and helpful.

Mr. S. Southcott seconded the vote, saying the evening had proved most interesting to those who were average foundrymen. The reply given to Mr. McClelland was of great interest, and all had derived quite a lot of good from attending.

The President called upon Prof. Read to support the vote, and in doing so the Professor said he had listened with a great amount of pleasure, pleasure because Mr. Griffiths was an old student who had gone out and risen to the height of his profession, holding a very important position with the Mond Nickel Company. The lecture had really been one on progress, and the progress which was going on at the present time had brought metals, which a few years ago were rare, into almost common use.

Mr. Griffiths said he need hardly say he was pleased that the meeting had enjoyed his remarks. He really could not resist the opportunity of coming back to his old lecture room and saying something there himself. His first lessons in metallurgy were received from Prof. Read in the very room in which the meeting was held, and it was a pleasure to try to pass on some of the material learnt in those days.

The Moulding and Casting of Bronze Plates.*

By Robert Liddle.

A few years ago the author was asked if he could cast a brass plate solid easier than he could cast one of the same shape and size with 900 cored holes. The diameter of the holes was 2 in. and of the plate 13 ft. Having no experience of the latter, and taking into account the greater weight and lesser finishing of the solid plate, the former method was preferred. The order was for two plates 9 ft. 6 in. dia., two 10 ft. 6 in. dia., and two 11 ft. 6 in. dia. Fig. 1 shows a section of the plates.

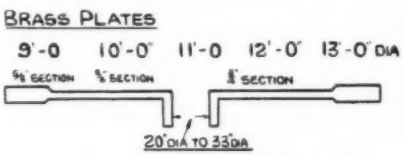

FIG. 1.—SHOWING A SECTION OF THE BRONZE PLATES.

The plant made for this job consisted of a moulding box in four parts, two parts being used for drags or bottoms, and two for tops—the joints crossing at right angles so as to stabilise the binding of the job (Fig. 2). The

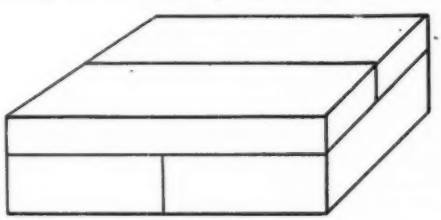

FIG. 2.—FOUR-PART MOULDING BOX.

dimensions of the box were approximately 14 ft. by 12 in. deep for drags and 10 in. deep for tops. The usual method was to ram sand in the box and strickle on a coating of loam by means of a spindle and strickle, as shown in Fig. 3.

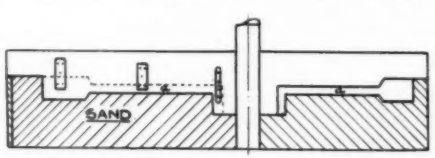

FIG. 3.—METHOD OF STRICKLING ON LOAM COATING.

When this was sufficiently hard, the thickness piece "a" giving the thickness of the plate was taken off the strickle, the thickness filled up with sand and skinned with loam, which was allowed to set. Drying was done by use of town gas and compressed air passing through two rubber tubes to a brass nozzle, which gave a fine flame for the purpose.

The next operation was to remove the spindle and strickle and place the two top-parts in position; these were then rammed up, staked and marked for closing. The parting and finishing of the top-part was next completed, and this part placed in the stove to dry. The thickness piece "a" was then scraped out of the bottom-part, and in the case of plates with cored holes the template for the holes was tested on the bed of the mould, and if correct the cores were then rammed up in place, care being taken to ensure correct positioning of these holes, as they had to be exactly the same as in the plate with which it was connected. The drag was then finished and stoved for drying.

When closing the mould the bottom-parts were placed on the original bed, a permanent structure for the purpose of ensuring easy setting and binding of the mould. The joint shown in Fig. 3 was then made up and dried with the blow pipe. The first top-part was then placed in and adjusted for correct position, the second top-part followed, the joint between the two made up, and the mould weighted and bound for casting.

On receipt of this order the whole method of moulding the plates was reconsidered. Being primarily a loam moulder, the author believed that almost any profile could be swept out by means of a strickle, and that most loam moulds can be used over again simply by skinning up the original building. He also believed that the more intricate the mould, the greater is the need to save the loam mould wherever possible. This may be a digression, but it leads directly to the points to be stressed.

It was decided not to make this order for six plates by the method usually employed and as already described. Instead it was decided to build up the moulding boxes, mould the castings in loam, and use the same building for the six plates. The method adopted was to place the drag part on the bed as usual, and to sweep up the bottom, as already described. At the same time the top was bricked up, and by means of a self-contained centre jib this part was also swept up. This obviated the operations of drying the drag, then putting on the thicknessing, and drying again, and allowed the moulders to prepare both drag and top at the same time—a larger squad being employed. It also obviated the necessity of having to turn over the top before finishing.

In practice it turned out very well, as far as moulding time was concerned; in fact, it proved a cheaper method of making the mould than the older method of making the sand mould, and to all appearances it was an equally good mould. The closing, casting and stripping was exactly the same as in a sand mould.

Early in the morning after casting the labourers took off the top and turned it over, and lifted out the casting. The moulders started on the second plate of the same size when they came in. The squad on the drag removed the old face of loam from the brick work, roughed it and skinned it, and as the roughing was hardened by the heat in the mould there was no necessity to use gas for this purpose, nor to wait very long for this hardening. This work was hastened and simplified by retaining the spindle socket in the mould while it was being cast.

The operation of finishing the top this time was slightly different from the first. The first section of the top-part was placed in correct

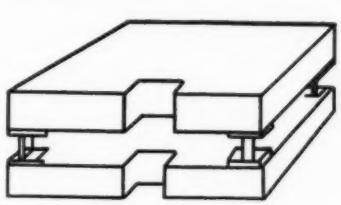

FIG. 4.—SHOWING THE FOUR STOOLS ON WHICH THE SECOND SECTION OF THE TOP WAS PLACED.

relationship to the spindle jig. Four stools (Fig. 4) were placed on this part, and the second section of the top was placed on these stools, also in correct relationship to the spindle jig. This was done to save space. The upper part was then skinned up and removed, the strickle dropped, and the lower part was also skinned up.

By the time this was done the first casting was cleaned up. It looked a perfect casting, and was passed as such. Two other plates were then cast in the same manner and in the same mould. About the time the mould for the fourth plate was being dried, the first plate was being machined, and it was then discovered that there were some gas holes in the flange, and a replace casting was immediately demanded.

The fourth plate, like the third, was a foot larger than the first and second. When it was cast and inspected, lines of lamination and dull running were showing on the surface. The plate was at once scrapped and broken up, and it was then found as shown in Fig. 5. The average

FIG. 5.—APPEARANCE OF THE FOURTH PLATE, SHOWING TWO DISTINCT LAYERS OF METAL.

thickness of the plate was $\frac{3}{4}$, but it appeared, much to the author's surprise, as two distinct layers, about $\frac{5}{16}$-in. and $\frac{7}{16}$-in. thick.

Thus there were four plates, cast in the same mould and by the same method, of which two were bad, and these quite as sound-looking as the two yet to be machined. While investigating the cause of these defects, much advice came in from all directions. Most of it was quite useless and some of it quite impossible. Finally it was decided to cast the next plate at an angle or slightly inclined towards one end. This was done, and as soon as it was taken from the mould it was dressed and sent to the machine shop, and the directors had the satisfaction of seeing a perfectly sound casting.

The next casting was cast in the same way, but two additional gates were provided. This also proved to be a good casting, and seemed to indicate that casting these plates on an angle was the correct method.

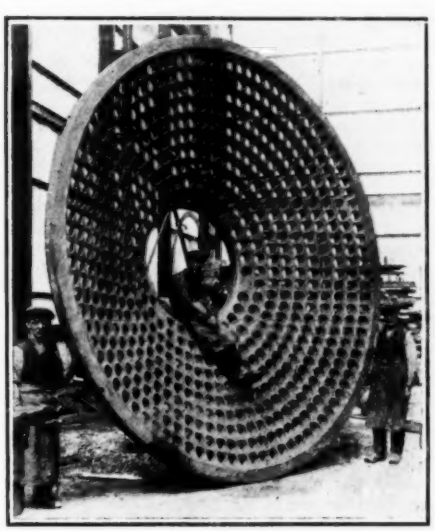

FIG. 6.—CONICAL TYPE OF BRONZE PLATE.

Looking back upon it afterwards it seemed to me that the cause of the lamination referred to (Fig. 5) was the spreading over the surface of the plate of a mass of metal which did not fill the thickness of the mould, and when it reached the circumference, the return flow passed over the outward flow, which had practically cooled but did not unite with it, causing a lamination or cold-shut between the upper and lower parts.

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* A Paper read before the Scottish Section of the Institute of British Foundrymen, Mr. J. Miller presiding.

When casting a plate with cored holes this difficulty did not arise, because the presence of the cores retarded the flow of metal, and as the distance between the cores was approximately equal to the thickness of the plate the metal flowed direct to the circumference without any return flow. Since the foregoing experience many bronze plates have been cast by this method, with more successful results and at less cost than formerly.

Fig. 6 illustrates another type of plate used for the same purpose as the flat one already described. At present it would seem the demand is for this conical type of plate, because under equal conditions and dimensions the same pan fitted with the cone-shaped plate is more easily cleaned, and two boilings per month obtained extra on output if 50 or 60 tons of sugar juice is the capacity of the pan. This would appear that the designer of this plate had obtained its conception from his working experience of such a plant.

It is now proposed to consider the best methods of the founding of these castings to give the best possible results as to reliability, efficiency and economy. Fig. 7 is common to all three types of bottom-tube plates. The top-plate will be dealt with later.

The material needed for this job is a bottom-mould plate, spindle centre or socket; spindle shear arm; board and gauge stick; templates and core box for tube holes; building rings for the bottom half of mould; top-part plate; grid-irons with lifters, and toggles, also building material, brick loam and other moulding media, as shown assembled in Fig. 7. Assuming the tube-plate to be 11 ft. dia., the size of bottom-moulding plate will be 12 ft. 8 in. dia. to ensure a 10-in. margin at the joint.

The building rings are made to clear the casting at its largest sections, which is the outside flange, either vertical or flat, according to the style of plate to be cast. The rings can be cast ready to build in place before setting of the bottom board or building has been started on the bottom half of mould.

Four rings will be ample for, say, a depth of building 3 ft. 6 in. from bottom-plate to joint. This will eliminate the ramming of the mould and ensure uniform resistance in the casting or filling operation. These building rings are cast in an open sand mould and dusted separately, each being ¾ to 1 in. in thickness and 7 or 8 in. wide in section.

The bottom board is now set. This half of mould can now be started and built up to, say, 1 in. from the board face. The spindle and board removed, a fire of coal or other fuel is placed in the centre, and the mould dried to a good depth into the building. The reason for this operation of firing here and at this time is twofold—primarily it eliminates the lifting on and off the stove carriage, and also the bestowing of the intense heat of the fire on the brick face, whilst doing no harm to the building; secondly, it is a quick method of drying, with very little attention.

If a suitable top-part plate is not available, one can be made while building the bottom half of mould. Personal practice is to make this plate light, but with a rib formation running round the rim of plate and another deeper one round the centre at 30 or 36 in. dia. These circles are joined with straight ribs where they are considered most suitable to their purpose. The depth at the outside is 2½ to 3 in. and the same size in thickness, and deepened to 5 or 6 in. at the centre. A plate 2½ or 3 in. thick, weighing 7 to 8 tons, will carry a load with little deflection, of, say, 22 tons of combined building and plate. Holes are formed by cores of various sizes to suit either lifters, gates or risers.

When cold it is cleaned and set upside down, and the spindle centre is fixed. The spindle and board arms are set to receive the board, and are gauged to size and depth. The building operation of the top-part of the mould may be started, one course of brick being laid to the height of the ribs and suitable to receive the laying on of the first grids, which are usually in four parts of a circle, and either covers or carries the runner to spraygates, as shown in Fig. 7, according to the type of casting. The building up to other levels is carried on till all the grids are in place. The whole is then roughed with loam and allowed to stiffen, afterwards it is skinned up and proved correct to size and depth.

Centre lines are marked on for setting in position the bottom half of mould when closing. The gates and riser holes are examined, and if found to be correct this part of mould is finished with blacking and placed in the stove to dry. The bottom half of mould has previously been dried and the fire cleaned out.

The spindle with bottom board is placed in position, and the operation of roughing and skinning is accomplished under ideal conditions to stiffen the completed mould face, which is also

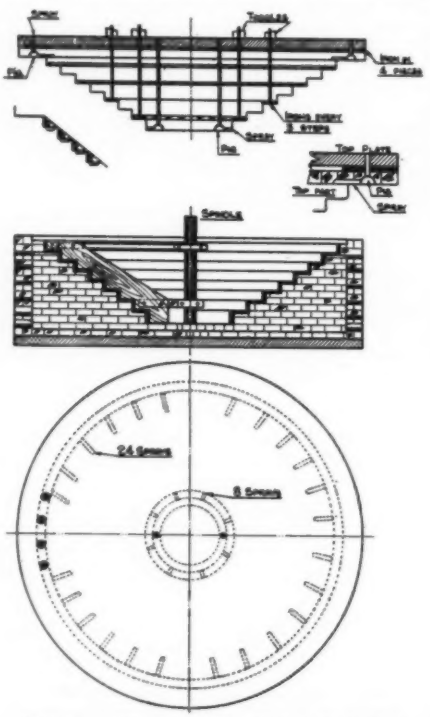


Fig. 7.—Showing Moulding Material assembled for Constructing all Three Types of Bottom-Tube Plates.

proved to be correct in size and depth. Centre lines are placed to correspond to those already described on the top-part of the mould.

Coring.

This part is now blacked and finished, and a very fine face results. After this, the proving of templates to the various steps of tube plate is carried out. The holes are marked off, and the cores laid in place with the aid of plumbago water, and "Kordic" solution and two sprigs. These cores are made of sharp sand and "Kordic" milled 5 or 6 min., which gives splendid results, as this composition can stand up to abnormal drying heat, and in casting the bond is completely perished, this assisting the dressing of the casting. They can also carry a tremendous strain by compression. For example, 100 cores 4 in. dia. have in a closing operation proved (when set too high by mistake) to be able to carry a top-part clear of the joint a ¼ of an inch, which load would weigh approximately 20 tons. The damage done to cores was almost nil, as only a few were found chipped on the edge, and that may well have been by faulty chamfering. This operation of coring completed, the whole is inspected. If correct the mould is lifted to the stove carriage for drying, unless the load is too great. Larger plates than the dimensions shown in Fig. 7 are usually dried in place with the aid of a portable furnace, and the time allotted to dry is 66 to 72 hrs., and this period if possible being arranged during a week-end.

Closing the Mould.

The top-part is taken from the stove carriage and placed on logs, to toggle lifters from the grid iron to the top-part plate before turning over. This is usually an important but very disagreeable task to the men allotted to the job, and while the demands for the crane may be urgent, if at all possible, it is left with this squad to complete the binding of building to the top-part plate and its turning over as soon as possible. After this it is again propped up with logs, and the mould face is examined for cracked or defective places. These (if found) are repaired, and if possible made perfect. During this time another squad have made the bottom half of mould ready to receive the top. The closing operation here in sequence is:—Dusting cores with peasemeal; placing clays on all sections doubtful as to thickness and formation of mould profile; the laying on of top-part; then the proving of corresponding centre-lines and guide between the lines, and, if found necessary, new marks placed on, and the top is again lifted and the whole mould examined and finally laid on.

Gating and Risering.

The mould is now bound together with four 1¾-in. bolts fastened to the bottom-plate and passed through holes in binding bars laid over the top-plate of mould and screwed tightly. Two additional bolts of the same size are used equidistantly placed; these six bolts, 60 deg. apart, have been found sufficient for all purposes so far. A head box or crib plates are used, whichever is more suitable, to the gate arrangement on tube-plate, as this differs owing to the size of plate and type, as shown in Fig. 7. The toggles are, if possible, removed at this time to assist a later operation. The mould is now made quite safe by binding, and this allows of their removal with ease. The head is made up to a height of 18 in., and risers flow over at 6 in. above the top-plate.

Pouring the Casting.

Six or eight gates or inlets are used, according to the weight and dimensions of the plate to be cast. Two of these gates are at the centre, 4 or 6, to runners shown on the outside dia. in Fig. 7. These gate inlets have to be of greater area than the runners to be filled, which are also larger in area than the feeders to the mould from the runners; the reason being to flood the runners and to cause to rise to the top any dirt or sullage, and ensure clean metal entering the mould.

Stoppers are used to secure the filling up of the head before lifting out. This also equalises the temperature of the metal to all the gates as they each take their quantity. Also as the centre gate stoppers are drawn first, the time is usually taken from a stop watch to record the actual time in filling the mould with the molten metal. This is the time the first plug or stopper is lifted to the exit of metal through the risers on the top, and is from 28 to 35 secs. If the filling operation exceeds this time some of the plugs have not been drawn quickly enough, or, worse still, the metal is in bad condition. This time has been proved on many castings of this type, totalling approximately 60 tons, the weight of plates being from 22 cwts. to 3 tons 10 cwts.

The next operation is the removal of the risers and overflow metal from the top-part. The head being drained clean by the lower depth of risers, this is done very quickly. The crane is now in attendance to assist the removal of binding bars; the stools used as props in binding and the nuts from bolts removed. This also is

accomplished with as great a speed as possible, as is also the head box or rib plates. The sand is thrown from the top-part, and gate holes are cleaned out with aid of steel bars to free the top-part when lifting off. As the toggles are removed, the top-part is now lifted off and the runners are exposed and broken up and thrown in a heap to be separated from sand and brick later. After the removal of runners, the brick and grids of top-part building are also removed. The method here is to use the crane on two lifters close together and a strain placed on it. The grid is rapped with steel bars, this energy is communicated to the grid, and that operation is carried round the circle of lifters on the grid iron to be removed. This straining action accomplished, the removal takes place, and bricks to the next grid, which is still lower, are thrown out, and after a like operation of straining and rapping the following grids and their removal is accomplished. All hard building is then taken away. This ensures safe passage for the contraction of tube-plate, and up till now this method has given satisfactory results, as there has only been one plate that was sprung, a half plate, which was cast in winter time about January, when the foundry was uncovered on one side, because of alterations, which may have been the reason for the trouble experienced.

A load of 35 tons approximately has been removed in the form of binding bars, bolts, stools, head box, sand, top moulding plate, runners, and building material in the top part, in the time from casting to completion, of from 45 to 60 min. This task is unpleasant and exhausting to those who accomplish it, but it must be acknowledged here that they score over the old bell masters of the past. This operation is a vital one in the constructing of a sound casting, in the sense that all conditions pertain to perfection in operation. This easing or slacking scamped, what effort, initiative, care and time can be thrown away!

Making the Upper Plate.

As the grid irons were made to fit both top and bottom tube-plates, a start is again now made on the top tube-plate, that is on top-part plate next morning. It is set upside down; the spindle is fixed in centre, and the board or strickle is set to size and depth. This board differs from the one used for the bottom-plate, as the profile here is a truncated cone. This section is easily built, the face of the building is of loam brick to allow the fastening of the tube-hole cores with the aid of sprigs, which are knocked in as required. The operations in building and setting grids are the same as for the bottom-plate top-part. When it is skinned up, it is allowed to stiffen and centre lines are placed where necessary, and the tube-hole core-box is tried on its place or circle, which has been scribed by the aid of small sprigs set equidistant on the sweep board. These lines on the mould face are determined by the diameter of each step on bottom side of plate, as shown in Fig. 8.

And now a start is made to ram in place the cup-shaped tube holes. This operation is very important, and must be done exactly. The first row is the bottom circle in the tube-plate, which is made upside down and is the top position at present on top-part. Also if possible in the scribed line of the circles, four or more lines are divided equidistant, for the proving of the ramming process of forming the core on the top-part. This also is helped by commencing at one line, and if, say, 10 holes is the number to the next line, place five holes and set the core-box on next line and work back. This has been found to leave no discrepancy of distance when the circle is finished, as would be found by spinning the circle complete, as the box is liable to be lowered in ramming or extended in placing in the setting and when finished; ¼ in. may have been found by difference, either larger or smaller to the diameter of the circle worked on. This circle of holes now completed, the next circle is started, the box for this second row sits again on the angled profile of top-part, but the inner edge of box is placed against the cores already placed on the circle finished. The same procedure is carried through till all the cores are fixed in position, then the top-part is examined, and if found correct it is finished ready for the stove. That is the practice adopted at present

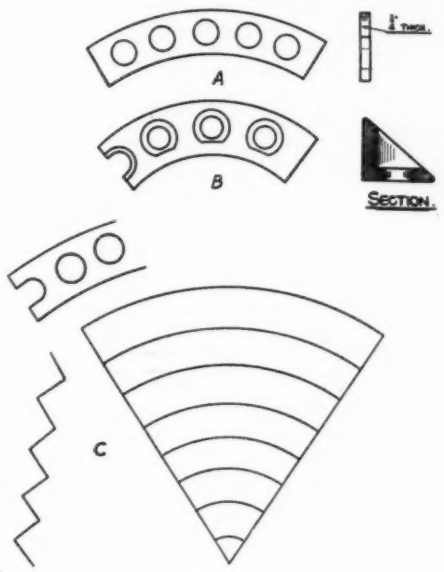


FIG. 8.

for the forming of this section of tube-plate mould. Referring to Fig. 8, which shows two other methods which were tried, and as far as the castings were concerned were quite successful in results, but the time spent and material used being much more costly, they were discarded and the present method became standard. The original method was to sweep the top-part of this plate like the profile of the bottom-plate top-part, as shown in Fig. 8 A, and a core-box made to fit the section, to be made up to shape, of

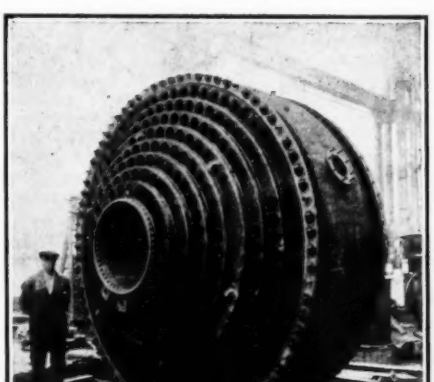


FIG. 9.—A SECOND TYPE OF BRONZE PLATE.

the contour of tube-plate. This core-box in outline was circled to radius to fit the inside circle of tube holes, also the outside of holes, and was square in vertical section with circled pattern like the template core-box used presently, inserted; this gave free access for ramming the cores, but it entailed the use of irons of some sort, and grids were made to carry and fasten down utilising spikes or tie wire to the various steps formed on the mould face. No matter how much care was taken this face was liable to crack or open up at points of some of the core sections. This entailed a considerable amount of time repairing at the closing operation.

Another method was with half-plates cast singly, the drawing C (Fig. 8) showing holes in line to the centre of the plate at 60 deg. These half-plates had vertical flanges. A segmental core-box one-sixth of the circumference of the full mould was made with the mould face complete on the bottom side of box. The top edges of the box were swept with a strickle made to fit the profile of the top-part, which in shape was bevelled like the present method, but smaller in diameter to allow for the bearing seat for the core. Three cores were needed for each half, and while a good mould face resulted, the cost in time was very high. The time in pattern-making alone being very expensive, and although the core irons used did both castings and the building of the top-part was saved and could have done many more times, it was found to be too costly over all, and the only improvement at present is the mechanism of the wheel-moulding machine applied to the operation of ramming and setting of these cores.

This covers personal experience in the various methods outlined, and it is proposed briefly to explain the operations on the bottom-part of this tube-plate mould. The casting, having been removed from the mould and the loam stripped off the mould face, the board is set, and the usual operation of roughing up and skinning is performed as in last plate, centre lines marked off, and templates tried out, and the sections filled up as shown in Fig. 7 to form thickness round tube-holes. Originally these sections were scraped out from a smaller diameter of steps, but this was found the better way, as little trouble is experienced when making up or closing the mould. After all these insertions are placed in position the mould is now inspected, and, if found correct, the finishing is completed and the mould dried. The closing follows, as previously described, and other operations are performed in the same way. Then follows the binding and pouring the casting. This is briefly the procedure in moulding bronze plates as followed by Messrs. Blair, Campbell & McLean, Limited,* and the author would like to take this opportunity of thanking them for their kind permission to present this Paper to the Institute.

DISCUSSION.

The PRESIDENT (Mr. J. Miller), in asking for discussion, thought that they would all agree that he had presented a very able and practical Paper, in which had been detailed the method of handling an exceedingly difficult proposition.

Oxide Film Causes Wasters.

MR. J. LONGDEN (Past-President) said the castings dealt with presented a particularly difficult proposition, and he thought that a foundryman required a great deal of hope and faith in a good Providence when he started on such a job. He would like to have a little more information regarding the first plate described and which swelled in the middle. He would like to ask if, in the later ones which were successfully cast on the bank, the head was raised at all in addition to the extra gates. He would also like to know what mixture of metal was used for casting the plates.

MR. LIDDLE replied that in the case of the scrapped plates they were broken on the fire. He thought that gases got trapped and on the removal of the heat fracture took place. In some sections they could be split in two parts down the centre. He thought that in running the metal from the centre the metal acquired an oxide film, breaking up the metal. He thought that the metal ran in a layer on the bottom half of the mould to the outside and the return flow of metal in the top half was kept

* Now Blairs, Limited, which incorporates the firms of Blair, Campbell and McLean, Limited; The Harvey Engineering Company, formerly McOnie, Harvey & Company, Limited; and A. & P. W. McOnie.

from uniting with the lower layer by the oxide film. Regarding the mixture, his firm preferred to make it to specification. They were not confined to bronze, it might be phosphor bronze or cheap brass, whichever the customer desired.

Gating Arrangements.

Mr. McCulloch asked whether Mr. Liddle could give them any idea of the temperature of the metal at the time of pouring? In the case of the plate run from the centre, how many gates were there and what was the size of them? How many ladles were used in casting these jobs? Could the author tell them the mixture of the core sand he used to give cores capable of standing a load of 22 tons? He would also like to know the mixture of the material of which the mould was made.

Mr. Liddle replied that as regards the gating arrangement, that depended on the size and weight of the plates. A 5-cwt. plate could be run with a gate 1¾ in. dia. His practice was to fill the mould in the shortest time possible. He had found that also in similar jobs that had to be machined. A plate weighing 30 cwts. would have 8 to 10 gates, he believed in having them 1¾ in. dia., but sometimes the flanges were only ⅞ in. thick, and it was not possible to get an inch hole, in that case he flattened the gates. In some cases he used as many as 20 tiny spray gates. With a vertical flanged plate that would involve runners as described in the Paper, and the grid would be removed like a drawback. On the top plate the gates would be the opposite way, and anything up to what the crane could lift, which was 25 tons, 24 ¾-in. spray gates would be used on the vertical. With regard to core sand, he would do anything with the mixture. He took it off the floor and mixed it with binder, which was Corbex, and it was cheaper than peasemeal For this job the sand was sifted and made sharp like parting sand. There were sometimes as many as 900 holes all cored out in the plate, and it was seldom that any of the cores needed to be repaired. The cores stood an enormous strain and yet burnt to nothing and knocked out easily. The difference between this mixture and oil was that it could be worked like ordinary facing sand. The temperature of pouring they liked to get was as near 1,200 deg. C. as possible.

He always cast with one ladle, as he believed in having a great head, whether for iron or bronze, and having nothing left in the head at the end. In the case of a plate 14 ft. dia., the head would be a strip about 10 in. wide reaching from the edge right to the centre. He did sometimes use a small ladle for filling the head. The mould mixture was ordinary sharp sand with little clay, but he did not believe in too much clay; he liked a quantity of loam, as it helped the floor. He got beautiful castings from what an ironfounder would use in the form of loam.

Sweeping Method Used.

A Member said that in addition to the method of moulding the 9-ft. 6-in. plates described by Mr. Liddle there were at least two or three other methods which could be used. A male and female sweep might be used, and another way would be taking an impression, as he thought the running-in of a thicknessing and taking away again was a waste of time.

Mr. Liddle replied that experience had shown that the most successful method was sweeping, as he had described. The box shown had two top parts and the same board swept two profiles. It was really a flat plate with little machining. He agreed that ramming a thicknessing is futile and a waste of time. He used two boards, male and female.

Mr. James Affleck (Past-President) said that he did not feel competent to say much about the technical aspects of the subject, but he thought that they should not leave without giving an expression of their appreciation of the Paper which had just been read. It was a proof that craftsmanship was not dead in the district. These castings might be said to represent the triumph of the moulder's art. Mr. Liddle's firm had shown an exceedingly broad-minded attitude in permitting Mr. Liddle to give them the results of many years' experience. He had indicated that a considerable number of methods had been tried in the production of these castings. He had given them the cream of them. Papers from practical men were always very welcome, and they were too few, but he always thought that when the practical moulder started to tell them about his work he was inclined to give them too much at once. This Paper contained enough matter for several lectures. The practical men were always very backward and required considerable persuasion to read a Paper, but when they did come forward they always showed that they had a wealth of information.

Honolulu Practice for Casting Plates.

Mr. Semple said that he had some diffidence in speaking on this Paper, as he was not a member of the Institute, but he had had a good deal of experience in the handling of these plates although not of the manufacture of them. His first experience of them was in Honolulu, where the plates were made by cores entirely. The first plates were about 10 ft. in diameter, and the people who made them were so successful that they became more ambitious and essayed the manufacture of plates 16 ft. in diameter. They cast the first eight right away without a failure. In all, 60 of them were cast, and there was not one defective. The men who made them were not men that one would normally expect to tackle such a job. They were iron-moulders, and he supposed that it was because they were iron-moulders that they were so successful. The holes in the early plates were not circular but hexagonal, and the cores were made for the bottom, although not for the top part. As every one of the plates cast at Honolulu were successful, he thought that in bringing these plates to this country they were not altogether bringing a new job. He was very much surprised to learn that Mr. Liddle could lower the top part on to the drag with 800 cored holes and obtain a perfect register. He was well acquainted with the work of Messrs. Blairs; it was excellent, and he wished to thank them for permitting Mr. Liddle to describe the method of manufacture, and he also wished to thank the Institute of British Foundrymen for allowing him to attend the meeting.

Vote of Thanks.

The President said he, as one responsible for the control of foundries making castings in steel, malleable and grey iron, felt exceedingly thankful that he had not also to be responsible for a brass foundry making such castings as had been described by Mr. Liddle. He agreed that when they ran a good loam mould it could be roughed and skinned again with comparative ease. There was only one point that he had difficulty in understanding, and that was the manner of registering the top part and the drag of a mould in which 800 or 900 cores were placed. That, however, was a difficulty which Mr. Liddle had evidently overcome. It would appear from what had been said that the particular combination of sand and Corbex described was so successful that many of them would be anxious to learn more about it. He confessed that he had never worked with that binder. He thought that they could congratulate not only the lecturer but themselves on having such an interesting Paper. He agreed with what Mr. Affleck had said that they should be glad to have more Papers of that description from practical men, as they were there to help each other by discussion of their daily problems. He asked them to accord Mr. Liddle a very hearty vote of thanks for his interesting Paper and also to express their thanks to the firm of Messrs. Blairs, Limited, for showing so broad-minded an attitude in giving permission for the Paper to be read.

Mr. Liddle, in reply, thanked them for their expression of thanks, but if what he had been able to describe to them had been of interest he had been well repaid. He could not, however, claim all the credit for himself, as he wished to acknowledge the assistance which he had received from Mr. John Bell and Mr. John Blair, junr., in the preparation of the Paper and the making of the sketches to illustrate it. He was very appreciative of the help which these gentlemen had given him and was afraid that had it been left to himself the Paper would never have been read.

Chrome-Nickel Alloys.

At the recent Pittsburgh meeting of the Metallurgical Advisory Board of the Carnegie Institute of Technology and the Pittsburgh Experiment Station of the U.S. Bureau of Mines reports of the work during the past year of these two institutions were presented.

A special feature of the day was a contribution entitled "Chrome-Nickel Alloys—Constitutional Diagram of 18 Per Cent. Chromium-Iron Alloys with Variable Composition of Nickel and Carbon. Disintegration of 18-8 Alloys." Work on this subject by the Carnegie Institute was presented by Mr. D. V. N. Krivobok, metallurgist of the Institute, under whose direction the investigations are proceeding.

Alloys investigated ranged from 0.046 to 0.34 per cent. carbon, 17.20 to 18.38 per cent. chromium, and 7.82 to 8.57 per cent. nickel. A study of the constitutional diagram is presenting data on definite ranges of composition and temperature at which the material remains austenitic and non-magnetic—two essential properties for 18-8. Some conclusions reached were:—

(1) After heating for 100 to 250 hrs. at 650 deg. C. (this temperature being within the range at which decomposition occurs) steels become distinctly magnetic. The lower the quenching temperature the higher the flux density after reheating.

(2) In case of very low-carbon content (in this case 0.046 per cent.) the sample is but slightly magnetic until quenching temperature is raised to about 1,285 to 1,315 deg. C. At this temperature a very perceptible increase in magnetic flux occurs, due, probably, to formation of delta iron. When subjected to 100 to 250 hrs. at 650 deg. C., its magnetic curve shows the same characteristics as the alloys of higher carbon content.

(3) The higher the carbon content, the higher, likewise, is the flux density after reheating, except in case of alloy with 0.23 per cent. carbon.

Dr. Krivobok reported that they are investigating some 18-8 alloys to which other elements were added. Some of these "special" alloys show no decomposition at 650 deg. C. Further work is in progress.

The speaker referred to failures of some of the 18-8 materials in service, and expressed confidence that present researches will throw light on the causes and the remedies.—"The Iron Age."

Changes in Properties of Direct Castings of Hematite Iron.—Dr. Eugen Piwowarsky, in a recent issue of "Stahl u. Eisen," published the results of his observations of changes which took place in the mechanical properties of hematite iron from the time of tapping from the blast furnace to the pouring into moulds after passing through an acid mixer. The chemical composition and properties of sample bars cast in sand and in chill moulds directly from the blast furnace during the charging of the mixer and during the emptying of the mixer were tabulated, showing the changes over a period of 8 days, with an off-day on the seventh day. Sand castings had better properties when taken directly from the blast furnace, but chill castings were superior to sand castings poured from the mixer. In both cases an appreciable improvement in properties took place during the passage of the metal through the mixer.

Some Problems of the Steel Industry.

VIEWS OF MR. F. W. HARBORD (Past-President of the Iron and Steel Institute).

An interesting address was delivered to the members of the London Iron and Steel Exchange, at their monthly luncheon at the Great Eastern Hotel on Tuesday, November 18, by MR. F. W. HARBORD (Past-President of the Iron and Steel Institute), on some of the problems of the steel industry, including the problem of tariffs. Mr. J. Watson Slack (President of the Exchange) presided.

The first question considered by Mr. Harbord was whether the steel industry was fundamentally sound in respect of raw materials, and whether our facilities for shipping, receiving and despatching were equal to those of our competitors—for if we were fundamentally sound in those matters we were in a strong position. He did not believe there was anywhere in the world where the three essentials—ore, limestone and coal—were so near together as, or nearer together than, in this country, or where they could be assembled at less cost. Combined with this advantage, we had some of the finest ports in the world, and our works were nearer to the ports than were the works of our serious competitors, such as Germany, Belgium, France and Luxemburg. We had hematites in Cumberland and Lancashire, but they were not sufficient to supply our needs, and it was necessary to import from Spain, the Mediterranean and Sweden to make up the deficiency; in that respect, however, we were no worse off than our competitors.

As to low-grade ores, it was true that those in the Cleveland district were to a large extent, or to some extent, exhausted, or their depth was becoming so great that it did not pay to work them. Some of the biggest works, however, were still working the Cleveland stone. Others had to transport ore from Northampton, but the distance from Northampton to the various works was no greater than the distance over which ore had to be transported from the deposits to the works in Belgium, and there again we were in a better position than, or at all events in as good a position as, our competitors. There was some low-grade ore in Lincolnshire, but the cost of quarrying and delivery to the blast furnaces was probably lower than in the case of any ore in the world. It was true that the amount of coke required to smelt that ore was large, and that was a set-off against the cheapness of the ore; but on balance it might be said that the raw materials in Lincolnshire required for making a ton of pig-iron were as cheap as anywhere in the world.

As to our export and import facilities, most of our biggest blast-furnace plants were situated almost on, or very near to, the sea coast, and imported ore could generally be delivered on the sites of the works, or very nearly so. Thus it could be claimed that we were fundamentally sound in respect of our raw materials and of our facilities for export and import. Unfortunately, however, our ports were not equipped so well as some of the Continental ports; perhaps this was not wholly our own fault, but there was no reason why, by the expenditure of a reasonable amount of money, our equipment should not be as good as that at a great many Continental ports.

Equipment of British Works.

With regard to the equipment of our works (continued the speaker) some of the most modern of them were as good as anything in that respect, and some others were not far behind those of our competitors, but, on the other hand, a large number were out of balance—their ovens could not supply them with enough coke, and so on. Generally speaking, in blast-furnace practice we were behind America and the Continent, *i.e.*, our blast furnaces were not so large, but some of the blast furnaces were equal to any on the Continent from the point of view of output, assuming they were working on the same materials. Frequently one heard that blast furnaces abroad were attaining big outputs, but it was usually found that they were working with ores of between 50 and 60 per cent., whereas in Lincolnshire we were working with ores of about 25 per cent. Given the same conditions, our blast furnaces were not seriously behind those of our competitors.

As to the big open-hearth furnaces working molten metal, we were getting as much out of them as were our Continental competitors. Some of our open-hearth plants working cold metal were perhaps not quite so good as the Continental, but that was a matter which was being investigated seriously, and he anticipated that very shortly the difficulty would be remedied. Our ironmasters were fully aware of the shortcomings of their works, but their trouble was financial. Whatever we might lack in the way of equipment, it was not due to our being unaware of the position, but to the difficulty of raising money.

The Basic-Bessemer Process.

Commenting on the fact that we have no basic-Bessemer plants in this country, Mr. Harbord said that undoubtedly the basic-Bessemer process was much cheaper than the open-hearth, but the material produced was not so reliable. At the same time, for certain purposes the material was good enough, and for some special purposes it was better than the open-hearth material. Large quantities of steel made by the basic-Bessemer process—such as billets, sheet bars, etc.—were imported into this country, and the difference in favour of it, as compared with open-hearth steel, was from 7s. 6d. to 10s. per ton. It was a question for serious consideration whether we should not start a basic-Bessemer plant in this country specially designed for producing this class of material. One of the problems to be considered in this connection, however, was that of location. The important market for sheet bars was South Wales. If a plant were installed there it would be necessary to rely on imported ore or to transport ore from Northampton or Oxfordshire and incur heavy rail charges, and that rather ruled out the establishment of such a plant in South Wales. If, on the other hand, the plant were located in Lincolnshire, it would be necessary to ship the finished products, and the freight charges would probably equal the freight charges from the Continent to our works to-day. Notwithstanding that, however, the problem was one worthy of serious consideration. We had everything we required to make basic pig, except that our ores did not contain sufficient phosphorus, and we should have to import a little phosphate.

Comparison of Wages.

In a comparison of wage levels in this country and Continental countries, the speaker, quoting from the Report of the British Delegation on "Conditions in the Iron and Steel Industries in France, Belgium, Luxemburg, Germany and Czecho-Slovakia" (see our issue of July 10, 1930), pointed out that, including all family allowances, the average wages for skilled labour in Belgium were 53s. 9d., for semi-skilled labour 38s. 10d., and for unskilled labour 30s. 10d. In Luxemburg the wages were about the same. In France the wages were lower; for skilled workers they were 51s. 6d., for semi-skilled 40s. 3d., and for unskilled 32s. 2d. The level in Czecho-Slovakia was lowest of all, whereas in Germany it was the highest for the Continent. The wages for skilled labour in Germany were 68s. 6d., for semi-skilled 52s. 10d., and for unskilled labour 47s. The point that impressed him with regard to these figures was the small difference between the prices paid for skilled and unskilled labour as compared with the difference in this country. He did not believe anyone would suggest reducing wages in our iron and steel trade; though they were high as compared with those paid by our Continental rivals, we were compensated by the fact that there had not been a strike in the industry in this country for over 40 years. That was a great advantage.

Reorganisation.

Discussing the problem of organisation, the speaker said there was no doubt that combinations and amalgamations on sound lines were right, but he emphasised that they must be effected on sound lines. If three works were each producing the same materials, if all of them were working at half time, and if one were efficient and the other two inefficient, obviously it would be a very good thing to combine, to close down the inefficient works, and run the efficient works at full time. The issue of scrapping inefficient plant, however, must be faced squarely. There was only one valuation for a works, and all works must be dealt with on that basis, *i.e.*, that a works was worth what it could earn. He did not mean that it was worth what it was actually earning to-day, but rather what it might reasonably be expected to earn under reasonable conditions of trade, working at, say, 85 per cent. of its output. Any writing-down of plant should be done on that basis. Unless that issue were faced, any combination, amalgamation or rationalisation would be unsound financially, however sound it might be technically. One of the great problems in connection with combinations was that of the selling and buying organisation, and it was necessary to utter the warning that unless the selling and buying organisation was in very close contact indeed with the departmental managers of the different plants it might make serious mistakes.

Combinations were made in two forms. There was first the uniting of similar undertakings and concentration of production at one plant; secondly, there was the linking-up with subsidiary industries. He was inclined to think that the latter offered far greater possibilities than had been realised in this country. During a recent visit to Czecho-Slovakia he had been told by one large firm there that 70 per cent. of their products were made for subsidiary companies, so that they had to market only 30 per cent. That kind of combination could be effected in two ways, of course—either by obtaining financial control of subsidiaries, or by agreement; probably the financial control method was the more watertight, and less likely to lead to leakages. It was becoming the fashion to go in for very big combinations, but he was inclined to think that there was a point at which they became so big that they ceased to be efficient.

Rationalisation involved (1) drastic, and even ruthless, scrapping of inefficient plant; (2) the writing off of capital represented by such inefficient plant; (3) the plant which was stopped, but not scrapped, must be written down to a reasonable percentage of its value (if a plant were stopped with the intention of being used again a few years hence, it must be written down for a reasonable amount); (4) the necessity for providing reasonable capital for essential alterations or additions to plant in operation.

The Question of Tariffs.

Finally, Mr. Harbord discussed the problem of tariffs—though he was careful not to advocate either Free Trade or Protection, but simply to state the facts as he saw them. We in this country, he said, were faced with the fact that most of the big plants on the Continent were producing more than they could sell at an economic price. To hold their own they had to operate to within 90 per cent. of their capacity, with the result that there was a permanent

surplus, which could only be sold either at little above cost or possibly below cost. Protection was almost universal on the Continent, and, consequently, a large proportion of the surplus there was shipped to this country and sold at a price at which we could not produce, having regard to our higher wages, high rates, taxes and charges for social services.

First, this made it impossible for our works to operate at their full capacity; it increased the cost of production and it resulted in men being thrown out of work. Secondly, it created a feeling of insecurity in the industry, making it almost impossible to obtain capital for the necessary improvements in existing plants or the building of new plants. If carried on systematically over a series of years it could end in only one way—our steelworks would have to stop operation.

Much of the imported steel was the raw material for other industries—sheet bars, shapes for shipbuilding, etc., billets for wire mills and re-rollers. All these were important industries, which had to sell their finished products in competition with the world, and to whom cheap steel was, therefore, vital, if they were to maintain their export trade. If a tariff were imposed sufficiently high to prevent a large proportion of these classes of steel being imported—and unless it were sufficiently high to do this it would not help our steel manufacturers—one of two things would happen. (*a*) Our steel-makers, by working near to their maximum capacity, might be able so to reduce costs that they could supply home consumers at world prices; (*b*) steel manufacturers might not be able to supply home consumers at world prices, with the inevitable result that, if that were continued over a series of years, these subsidiary industries would slowly but surely dwindle and die.

As secondary results, on the one hand the Continental steel-makers, having no longer a free market for their surplus material, might not be able to run their works at their maximum capacity, and therefore might not be able to sell at a price below that at which we could supply our home consumers. On the other hand, the Continental steel manufacturers, finding that their market for semi-finished materials was cut off, would in all probability increase their manufacture of sheets, tinplates, etc., and compete to a greater extent with our manufacturers in these more highly-finished products. Although it would then take them a long time to establish themselves in markets at present largely controlled by us, this competition would gradually affect adversely our export trade in these finished materials and so reduce the demand for our semi-finished steel products in our home markets.

The position appeared to be that if we permitted steel to be imported into this country as at present, and sold at nearly cost price, or possibly below, and if this were carried on systematically our steel manufacturers would have to go out of business, in which event our home consumers of steel would be entirely in the hands of the Continental steel manufacturers, with no home competition to keep prices down. If, on the other hand, we restricted imports largely by a tariff, unless our steel manufacturers were able, by operating their plants nearer to their maximum capacity, so to reduce costs that they could supply our home market at approximately world prices, the industries on which they had to rely to purchase their products would die, and the final result would be the same as if unrestricted imports were permitted.

Free trade or tariffs was, in his view, merely a question of expediency, and support should be given to that policy which, under a given set of conditions, was likely to produce the best results. It was hopeless to rely upon any fiscal policy to solve the problem of our bad trade; in the end this could be solved only by producing more cheaply. The right fiscal policy might assist, or the wrong retard, but if from any cause, no matter what, we were unable to produce goods in competition with the world, the final result would be that we should cease to produce.

The steel industry in this country was fundamentally sound in respect of raw materials, and the proximity of our works to ports was unrivalled. There was no better skilled labour in the world, and we had the advantage of technical experience acquired during three generations. With these great advantages, if we did our part and faced the future with courage, confidence and determination, he was confident that we should more than hold our own.

The Association of Scientific and Technical Institutions.

BANQUET AT THE GUILDHALL.

At the Guildhall, London, on Thursday, November 13, the Association of Scientific and Technical Institutions, which was incorporated on September 15, 1930, "For the promotion and co-operation between scientific and technical societies and institutions within the British Empire," held a banquet which was honoured by the presence of His Royal Highness the Prince of Wales. Sir Ernest Rutherford, O.M. (President of the Royal Society), was in the chair, and some 500 guests took part in the function. Reference to the banquet and to the constituent societies and institutions of the Association was made in our issue of October 23.

Sir John Cadman (Hon. Treasurer of the Empire Council of Mining and Metallurgical Institutions), proposing "His Royal Highness the Prince of Wales," said that an enormous amount of work had had to be done in connection with the formation of the Association, for which thanks were due, among many others, to Sir Arnold Wilson and Mr. Charles McDermid (Joint Secretary of the Association *pro tem.*, Hon. Secretary-General of the Empire Council of Mining and Metallurgical Institutions, and Secretary of the Institution of Mining and Metallurgy and the Institution of Mining Engineers). Referring to the genesis of the scheme for which the Association had been formed, the speaker said that eighteen years ago the north of England mining engineers started the North of England Institute of Mining and Mechanical Engineers to deal with mining. That was closely followed by work in South Wales and the other coalfields, and 13 years ago several societies grouped themselves together and federated for the purpose of having a common secretariat in one premises. Ten years ago another movement was made, in which the Institution of Mining Engineers and the Institution of Mining and Metallurgy grouped themselves together to have common premises, a common library and a common secretariat. The effect of that movement brought a desire from other organisations to come into contact with the machine which had thus been created, with the result that the Empire Council of Mining and Metallurgy was formed eight years ago in the London Guildhall, when His Royal Highness was good enough to attend and give his blessing and assistance to that scheme. The result had been most encouraging, and on the previous occasion His Royal Highness had been kind enough to suggest that it might be possible, or that it should be considered, whether a further extension of this idea might not be possible so that other societies could be brought into the scheme. At the time the Empire scheme was devised, a terrific amount of difficulty was met by those organising it, but a great deal of advance had been made since, with the result that some dozen societies, connected with mining, metallurgy, oil, rubber, iron and steel, non-ferrous metals and chemical industry generally, had joined forces for the purpose of erecting a common building, with a common library and common leisure rooms and other appurtenances associated with scientific work to bring about more efficient and economical administration. Sir John Cadman expressed the view that the movement now in hand would be not only in the interests of the societies themselves but in the interests of the industries concerned and the community as a whole. The constituent authorities between them numbered some 30,000 members, and it should not be difficult to raise the large sum of money required.

His Royal Highness the Prince of Wales, responding, said that when he first heard of the scheme, of which the Association was the outcome, he welcomed it heartily, and he was glad to think that not only had the original object to which he gave his support eight years ago been achieved, but that out of it had grown a much greater enterprise. That had inaugurated a movement which, if steadily supported and wisely guided, might confer benefits upon industry as a whole, both in this country and in the Empire, the extent of which they could only dimly foresee. The Empire Council of Mining and Metallurgical Institutions had done much to help them to reap the full benefit of the wonderful mineral resources which the Empire contained. His Royal Highness believed that the Association might have a not less beneficial effect in an even wider sphere by promoting what an enlightened American recently referred to as the "four C's"—contact, consultation, confidence and co-operation.

Sir Robert Horne, K.C., M.P., replying to the toast, said the purpose of all scientists was to serve human progress and, by pooling their knowledge, they could render a great service to the Empire, because there was great difficulty in drawing strict lines of demarcation in science. There was no one branch of science that could not be a great benefit to the other branches, and they were all mutually supporting each other. Another important aspect of the matter was research, and in the pooling of this also there must be great benefits not only to industry, but to the community.

Sir Auckland Geddes, whose name, together with those of Sir William Larke and Mr. Eric Macfadyen, was associated with the toast of "The Guests," proposed by the chairman, said it was being more and more impressed upon him that the great industries of the country should be assisted by science and men of science, and, in turn, that the industries should come to the help of the scientific societies. He urged the industries of the country to come to the financial help of the scheme of the Association, and added that those with whom he was associated in industry were willing, indeed anxious, to help financially in the project. There were great problems waiting to be solved for the benefit of industry and the community which called for the help of chemists and engineers, and from science in all its branches.

Sir William Larke (Director, National Federation of Iron and Steel Manufacturers) said he represented an industry which was passing through a period of depression. In supporting the scheme for providing a central building, libraries, etc., for the technical societies, however, he said it was well to remember what the discoveries of science and their applications really meant. It was really no less than our modern civilisation of the last 50 years, and, if that was true of what had gone before, how much greater progress could be expected if the various scientific societies were to co-operate in the manner contemplated by the present scheme? The scheme provided for the co-operation of the intellect and ability of the Empire as a whole, and, having regard to the difficult times in which they were living, surely they should look for inspiration, in dealing with the present and immediate future, to the great and glorious achievements of the past, and go forward in confidence. Sir William added that he had been asked to announce a magnificent donation by Dr. Robert Mond of £10,000, and he could only express the hope that that worthy example would be generously followed in a cause which all present had so much at heart, because it meant so much not only for the economic unity of the British Empire, but its economic progress.

Expenditure on Research in United States.—Expenditure on research by rolling mills and steel plants of the United States is 0.04 per cent. of the capital invested, according to Dr. Frank Parker, professor of finance in the Wharton School of Finance and Commerce, Philadelphia. The average for all industries for which data are available is 1.03 per cent. The figure for chemical and allied products, spending the most, is 2.04 per cent. In an address before the American Institute of Steel Construction, Pinehurst, N.C., lately, Dr. Parker urged the extension of research programmes to cover production, marketing and distribution as well as the technical, and plans, he said, should be laid in terms of ten-year periods, as such are calculated "to obviate the needless changes in tonnage and profits." Quoting the most recent compilation of the National Research Council, he pointed out that all industries have an average annual research expenditure per plant of about $50,000, and that rolling mills and steel plants spend $16,200.—"The Iron Age."

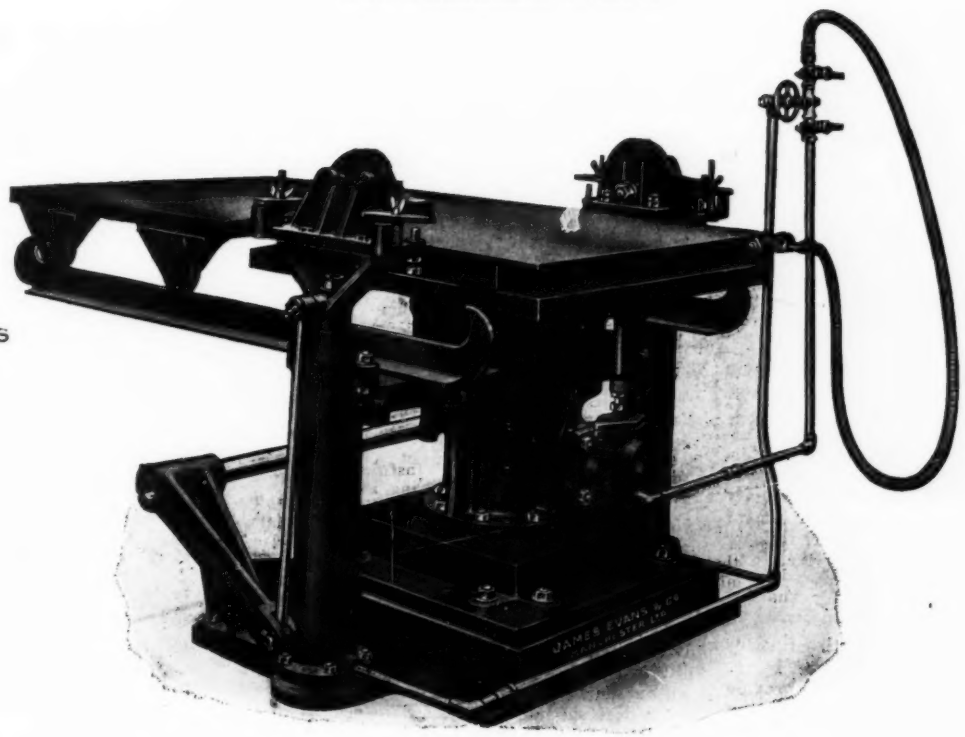
TYPE "C"

JAR RAM MOULDING MACHINE

with Turnover Pattern Plate.

For Pneumatic Power.

TWO MACHINES IN ONE.



UNSKILLED LABOUR ONLY REQUIRED.

The above machine illustrates a Jar Ram Machine with Turnover Pattern Plate which can also be used for Stripping Plate Work.

The machine has been designed to combine the two distinct features above mentioned, and is practically two machines in one, equally suitable for steel, iron, etc.

The machine as illustrated is arranged for work that requires turning over, such as steel moulding. And while the turnover arrangements are intended for general repetition work, by detaching the turnover plate from the trunnion brackets the machine can be used for stripping plate work by attaching the stripping plate to the trunnion brackets. Or, on the other hand, by removing the trunnion brackets as well, the table can be used for jolting general jobbing work.

A very important feature of the machine is the simplicity with which the intensity of the Jolt can be regulated when the operator has become accustomed to the use of the machine, which takes but an hour or so. The valves all being on the exterior of the machine are easily accessible, and there is an adjustable arrangement that will allow the jolt to be varied between 1½ in. to below ¼ in. This being done without disturbing any part of the machine.

The machine is supplied with Withdrawal Carriage, Vibrator, and Blow-off Nozzle complete. It is substantially constructed to stand heavy wear and tear, and requires a minimum amount of skill to operate.

Another important feature of the machine is in the arrangement of the hard wood anvil block for receiving the shock. The blocks being carried well down the machine in a specially designed annular chamber give considerable relief to the foundations. It also provides against the possibility of fracturing the jolting table. Pitch pine blocks are also inserted between the foundation plate and the machine bedplate to assist in the relief on the foundations, and these features considerably improve the working advantages of the machine.

IT IS ALSO ENTIRELY OF BRITISH DESIGN AND MANUFACTURE.

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Gas Flow in Open-Hearth Furnaces.

At a meeting of the Cleveland Institute of Engineers held at Middlesbrough recently, Mr. Edward W. Plumley read a Paper on "Attention to Gas Flow in Open-Hearth Furnaces for Increased Production," in the course of which he stated that the object of the Paper was to stimulate interest in a simple method of increasing production from existing open-hearth furnaces with a view to obtaining eventually outputs commensurate with those obtained by many foreign competitors. The Continental works were producing more steel per sq. yd. of bath area in unit time than Great Britain.

The most important feature of open-hearth operation, continued the author, is the gas flow. The maximum output from an open-hearth furnace is only attainable when the three flowing streams of gas have reached their maximum. The three streams referred to are air, gas and exhaust. If any one of these three will not reach a maximum up to the point where the refractories fail, the furnace is not giving its greatest output. When consideration is given to this question it must be remembered that the temperature of the flame gives no indication of optimum heat transmission to the steel. In the first place, there are no instruments to measure the temperature of a flame or the amount of heat a flame transmits. The temperature of the flame depends upon the rapidity of combustion or upon the amount of gas consumed in unit volume and time.

Gas Burned in Unit Time.

In order to increase the amount of gas burned in unit time it is necessary to increase the volume of the three streams—gas, air and exhaust. If the time taken for a charge is reduced and the output increased it is possible to reduce the fuel consumption per ton of steel; the author cited the case of a basic furnace of 50 tons capacity consuming less than 3 cwts. of coal per ton of steel made, without a waste-heat boiler, melting cold sheet-bar crop ends and scrap, etc., and burning producer gas.

Increasing Output of Existing Furnaces.

Assume an existing open-hearth furnace of 50 tons capacity, having a draft of 1¼ in. w.g., the latter is sufficient to provide draft at the end of the campaign, it being assumed that at this period both air and exhaust dampers are fully opened. The fuel consumption is assumed to be 5½ cwts. per ton and the furnace rate 11 heats per week of 150 hours. The average fuel consumption per hour is about 20 cwts. Assume also that when the furnace is transformed 22 heats per week are obtained with a fuel consumption per ton of 4 cwts. The fuel consumption per hr. will be about 28 cwts.

Consider the case of a simple tube for the conveyance of a gas. The draft required to move the gases through the tube at a certain velocity depends upon the resistance to flow, and for the present purpose it would be of advantage to describe the draft as the resistance. The resistance is the head required to move the gas at the velocity. The law governing the flow of gases is $H = \frac{V^2}{2g}$ so that the resistance to flow varies as the square of the velocity. The flue systems of a furnace are merely pipes for the conveyance of gases, so that if the gases are to flow at a higher velocity the new resistance can be calculated, using measurements taken before alterations.

Suppose the conditions to be met are those previously mentioned, and the fuel consumption is to be increased from 20 cwts. to 28 cwts. per hr. This represents an increase of $\frac{8}{20} \times 100$ = 40 per cent. The new resistance to flow must be 1.42, or a 96 per cent. increase. Assume the w.g. at the base of the stack was originally 1¼ in., this must be increased 96 per cent., or $1.25 \times \frac{96}{100} + 1.25 = 1.25 + 1.2 = 2.45$ in. w.g. There is a discrepancy in the method of calculation which has been purposely ignored for clarity; this is the effect of buoyancy in the vertical passages. Buoyancy factors are added as a constant to the above formula, so that it reads $H = \frac{V^2}{2g} + C$.

Each 100 ft. of stack height gives a potential draft of about 1 in. w.g. at the temperatures usually associated with open-hearth stacks, so that the new height of the stack must be at least 245 ft. high. Raising the stack height increases the frictional resistance of the flue system, so that an allowance must be made for this, and so it is advisable to add a further few feet to cover this. The stack will now be, say, 250 ft. high.

Unfortunately, it is generally impracticable to increase stack heights; it is therefore suggested that a waste-heat boiler and induced-draft fan be installed, the fan giving a potential head of about 2½ in. w.g. at the entrance to the boiler. If a waste-heat boiler is already in existence, but working at a lower capacity than the new conditions call for, the fan makers should be consulted. They will make recommendations with regard to alterations to realise the new conditions. This should generally mean a new prime mover and fan rotor.

The power required under the new conditions will be 174 per cent. greater than originally required. If the old fan rotor or impeller is increased in speed to meet the new conditions, it will be inefficient, and the wasted power will be a constant charge against the furnace.

Port-End Design.

The question of port-end design enters largely into the scheme. It follows that, if the volumes of gases entering and leaving the furnace chamber are increased 40 per cent., the velocities through the chamber will be increased 40 per cent. If the velocity of the gas is increased, it might be expected to burn the outgoing port block. A simple method of allowing for increased gas and its velocities is to destroy the kinetic energy of the gas and air by increasing the angle of the ports.

If the air supply is increased in velocity 40 per cent., it will have the effect of forcing the gas down on the surface of the bath. The mouth of the air port should be increased in size so that the velocity of the air is normal. Cold gas and air velocities suggested for trial are 20 ft. per sec. for gas, 8 to 10 ft. per sec. for air, and the angle of both about 20 deg. to the horizontal.

No furnace should be working to-day without instruments to indicate the following:—Pressure in the flues at the entrance to the regenerators and also at the base of the stack. Indicating pyrometers should show the temperatures in the regenerators. Other fittings may be installed to advantage to indicate the efficiency of combustion. Apart from the advantage of controllability of the furnace, a very valuable feature is that the whole of the state of the furnace is apparent without the necessity of leaving the charging platform. This in itself is a great help to the operators; the necessity for walking round the valve pits and regenerators is avoided, and so the control of the furnace is improved.

A question occurs with regard to the efficiency of the regenerators under the new condition of the furnace gas flow. It has been proved in practice that efficiency is increased. There is a greater volume of gases leaving the furnace in unit time, and also a greater volume entering. The sweeping effect of both in and outgoing streams will be increased by reason of the increased velocities. This is important, more so in the case of the ingoing air than in the others—gas and waste products. Air will not absorb heat by radiation efficiently. It must therefore receive heat by sweeping. If the velocity of the air is increased, it will reach a higher temperature before entering the furnace.

Tubes for Water-Tube Boilers.

At a meeting of the Institute of Marine Engineers, held in London on November 11, Mr. H. J. Vose in the chair, Mr. S. F. Dorey read a Paper on "Tubes for High-Pressure Water-Tube Boilers," in the course of which he pointed out that the ultimate success of the high-pressure water-tube boiler depended largely upon the quality of the material used for the tubes, and an assurance of homogeneous material was particularly desirable. Soft mild-steel tubes had been used largely on account of their relative cheapness and ease of manufacture, but with the high pressures and high temperatures now being adopted, attention was being drawn to alloy steels which were more suitable.

For tube material, continued the author, it is essential that the steel should be capable of resisting oxidation at the service temperature, and be able to resist satisfactorily for a prolonged period the stresses to which it is subjected. The high-temperature steam in contact with the inner surfaces of the tube is more likely to cause oxidation than hot gases in contact with the outer surfaces. In some cases, in order to protect the external surfaces of tubes from oxidation, the material has been coated with an alloy metal by means of a "calorising" or "aluminising" process. Experiments have shown, however, that with furnace gases having a CO_2 content above 12 to 14 per cent., the temperature at which oxidation commences is considerably higher than the metal temperatures likely in present practice. In the 1,420-lb. pressure boilers at the Mannheim Power Station 3 per cent. nickel tubes have been used in the hottest parts. The advantages of the addition of small quantities of nickel, however, seem rather uncertain as regards superheater tubes. In this respect it may be mentioned that recent research indicates that the addition of low percentages of nickel has an adverse effect on the creep properties compared with ordinary mild steels. An alloy steel known as Enduro metal, containing about 0.09 C, 0.34 Mn, 0.84 Si, 0.014 S, 0.021 P, 16.7 Cr and 0.19 Ni, has been tried for the last pass in certain superheaters in America, but this material appears to develop brittleness when held around 1,000 deg. Fah. for a long time, and accordingly its use has been discontinued.

Two tube materials which have become more prominent recently on the Continent, and the price of which is stated to be about 50 per cent. higher than that of ordinary steel tubes, are manufactured at the Thyssen Works, and are known as Th 30 and Th 31. The approximate chemical analyses of these steels are, for Th 30: Mo 0.2 to 0.3 per cent., Cu 0.2 to 0.3, C 0.08 to 0.12, Mn 0.5, Si 0.12, with P and S as low as possible; for Th 31 steel the carbon content varies from 0.16 to 0.18 per cent. The tubes are capable of withstanding the same mechanical tests as ordinary tubes. Th 30 can be welded, but for Th 31 the welding should be done by the oxy-acetylene process. Creep tests are not available at present, but the following are results of some comparative tests.

Material.	Stretch limit. Tons per sq. in.		Ultimate tensile. Tons per sq. in.	
	400 deg. C.	500 deg. C.	400 deg. C.	500 deg. C.
Th 31	17.8	15.1	32.6	24.0
Th 30	11.9	10.8	25.8	19.2
3 per cent. Ni ..	14.7	9.5	26.9	15.9
Mild steel ..	8.1	5.5	20.5	11.7

The yield stresses stated in this table are not the stresses at definite yield points. Professor Korber has shown that for soft steels the yield point ceases at about 300 deg. C., so that it becomes necessary to adopt some criterion of minimum plastic strain. For practical reasons he adopts a 0.2 per cent. limit, and the yield stresses given in the table correspond to what is known as 0.2 per cent. proof stress.

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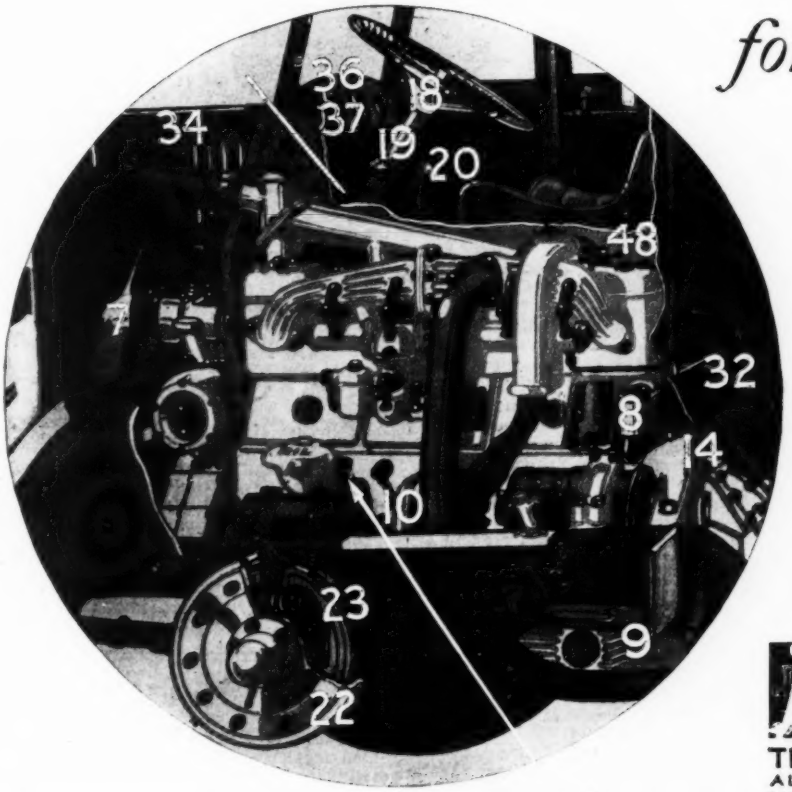

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CORE GUM
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COAL DUST
REQUISITES

Trade Talk.

Regent Malleable Castings, Limited, are being wound up voluntarily.

The Wynnfield Iron Company, Grimsby, have changed their address to 4, Victoria Street, London, S.W.1.

The Patent Axlebox & Foundry Company, Limited, Wednesfield, has ceased operations, and the workshops have been closed.

The Shelton Iron, Steel & Coal Company, Limited, have removed their London office to Blackfriars House, New Bridge Street, E.C.4.

The Wearmouth Foundry Company, Limited, is being wound up voluntarily. Mr. J. E. Parker, 56, John Street, Sunderland, is the liquidator.

The Clydesdale Steelworks of Messrs. Stewarts & Lloyds, Limited, which were closed on November 15 owing to slack trade, were restarted on Tuesday.

The Poole Foundry, Limited, is being wound up voluntarily. Mr. Leslie Goodwin, 112, Old Christchurch Road, Bournemouth, has been nominated liquidator of the company.

The employees of the North British Locomotive Company, Limited, at the Queen's Park Works, have this year distributed over £630 amongst Glasgow charitable institutions.

Messrs. R. A. Lister & Company, Limited, of Dursley, Gloucester, have opened new showrooms and offices in Imperial House, Kingsway, London, W.C.2, in order to enable them to cope with increasing business.

Messrs. J. W. Jackman & Company, Limited, of the Vulcan Works, Blackfriars Road, Manchester, have received from the Austin Motor Company, Limited, of Birmingham, orders for the full equipment of moulding and core-making machines of the Osborn type, in connection with their new foundry reorganisation scheme.

The Caledon Shipbuilding & Engineering Company, Limited, Dundee, have launched the twin-screw motor vessel "Skotaas," built for the Aktiebolaget Gotaverken, Göteberg, Sweden. The propelling machinery consists of two sets of four-cycle single-acting Diesel engines, and will be supplied by the Aktiebolaget Gotaverken.

The North British Locomotive Company, Limited, have completed at their Hydepark Works, Springburn, eight locomotives for the Nankin-Shanghai Railway. Each engine has a double-bogie tender, which carries a mechanical stoker. The tank is capable of carrying 6,000 gallons of water, and there is space for 12 tons of coal.

An important order recently completed by the General Electric Company, Limited, was for seven 5,500-k.v.a. single-phase transformers for the electric power scheme at Waitaki, which is being carried out by the Public Works Department, New Zealand. Six of the transformers will form two 16,500-k.v.a. three-phase banks, the seventh transformer being a spare.

Messrs. Grandidge & Mansergh, Limited, Wheathill Street Works, Salford, Manchester, have been appointed sub-agents for the Lancashire and Cheshire area, under Messrs. John A. Smeeton, Limited, of 15, Victoria Street, London, S.W.1, to exploit the sale of all classes of foundry machinery as manufactured by the Badische Maschinenfabrik, of Durlach.

Messrs. Newton, Chambers & Company, Limited, Thorncliffe Ironworks, near Sheffield, have made arrangements with Mr. Arnold Walters, director of Messrs. Christmas & Walters, Limited, of 8, Grosvenor Gardens, London, S.W.1, to represent them in respect to the products acquired from Messrs. Dewhursts Engineering Company, together with their present steelworks specialities.

Sir William Arrol & Company, Limited, of Bridgeton, Glasgow, have secured an order from the Mersey Docks and Harbour Board for the supply and erection of four rolling bascule bridges at Liverpool. Three of these bridges each have opening spans of 80 ft., whilst the fourth has an opening span of 100 ft. This will allow the passage of large vessels in and out of the docks. Work will start immediately.

The Calderbank Steelworks, as carried on by Messrs. James Dunlop & Company, Limited, were closed for an indefinite period on November 22. The stoppage is understood to be due to the merging of the business with that of Messrs. David Colville & Sons, Limited, Motherwell, a full report of which appears on page 382. About 600 men who have been on a day's notice for some considerable time will be affected.

The proposal of Thos. W. Ward, Limited, to acquire the undertaking of the Laycock Engineering Company, Limited, Millhouses, Sheffield, has been sanctioned by the Court, and the new owners are considering a scheme for continuing the business. This was founded in the early 'eighties by the late Mr. W. S. Laycock, and was incorporated as a limited company in 1900. The works are equipped with modern machinery for the manufacture of all kinds of railway appliances.

The largest order ever placed in Denmark for steam-raising plant has been secured by the Stirling Boiler Company, Limited, 32/33, Farringdon Street, London, E.C.4. The contract is for the new Orsted Power Station of the Copenhagen Municipal Lighting Department, and comprises eight tri-drum Stirling boilers, the total evaporative capacity being 844,800 lbs. of water per hour, overload capacity 1,244,800 lbs. per hour, working pressure 356 lbs. per sq. in., and final temperature 752 deg. Fah., together with mechanical stokers, Bailey walls, air heaters, economisers, forced- and induced-draft plant, equipment, etc. The order was secured in the face of keen Continental competition.

Serious damage was done by a disastrous fire, blazing in a high gale, at the Eastburn Foundry, near Keighley, of John Lund & Company, machine-tool makers. As a result of the fire the electricity supply to the village of Eastburn was cut off and could not be restored, because a transformer chamber in the basement of the building was wrecked. It is believed the fire originated in the pattern department among a large number of wooden patterns for moulding. The foundry proper, and the offices, were saved—as was the residence of Mr. Arthur Lund, head of the firm—by the high wind blowing the flames away from these buildings. We are assured that arrangements have been made for the normal continuance of the business.

Mr. W. Y. M'Math, of the Albion Motor Car Company, Limited, read a Paper at a recent meeting of the Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen on "Co-operation between Laboratory and Workshop." He said that all materials ordered for the engineering shops should be specified to comply with the requirements of such specifications as the British Engineering Standards, thereby minimising any tendency for supplying inferior-grade materials. Further, representative samples should be taken of the various consignments of raw materials and chemical and physical tests carried out before the material was despatched to the various departments. Mr. M'Math urged that the services of the laboratory should be utilised at all times in the fullest degree for the investigation and solution of workshop problems.

Arrangements have been made whereby the Whessoe Foundry & Engineering Company, Limited, Darlington, will represent Messrs. Arthur G. McKee & Company, of Cleveland, Ohio, in this country. The Whessoe Company have been appointed sole agents and licensees for the whole of the McKee manufactures and specialities. The major activities of Messrs. Arthur G. McKee & Company comprise complete engineering and constructing services covering the building of new and the remodelling of existing blast furnaces, steel plants and petroleum refineries. They also design, manufacture and erect many items of special equipment for the iron and steel industries. The McKee patented revolving distributor is one of their most outstanding items of special equipment. In this connection it is interesting to note that of the 318 furnaces listed in the United States, 205 of them are equipped with the McKee revolving top.

The Standing Committee appointed by the Board of Trade under the Merchandise Marks Act, 1926, recently, considered an application for an extension of the exemption period in respect of the marking of imported tools. Tools imported before December 17, 1929, which are sold or exposed for sale before July 1, 1931, are allowed to be labelled instead of being die-stamped, etched, or engraved, and Mr. H. C. Hole, for the National Hardware Association, suggested an extension of this exemption until the end of 1932. He said that importers and wholesalers expected to have large stocks still in hand at the end of the present exemption period. In fact, some of their stocks would not, he thought, be cleared for seven years, and he expected to have to ask for a further extension later. Sir Hubert Llewellyn Smith, the chairman, said that responsibility would have to rest with the committee. The recommendations of the Standing Committee would be made known later.

Reports and Dividends.

Birmingham Aluminium Casting (1903) Company, Limited.—Net profit, £25,266; brought in, £20,100; dividend of 7½ per cent.; to reserve for depreciation, £5,000; carried forward, £24,394.

Boulton & Paul, Limited.—Net profit, £29,807; brought in, £23,640; preference dividend, £2,500; dividend of 5 per cent. on the ordinary shares, £9,557; general reserve, £5,000; reserve for taxation, £4,000; carried forward, £32,390.

Cargo Fleet Iron Company, Limited.—Profit, £83,808; brought in, £185,455; debenture interest, £37,132; depreciation, £43,000; carried forward, £186,430.

South Durham Steel & Iron Company, Limited.—Profit, £85,043; brought in, £138,664; interest on debenture stock, £13,500; depreciation, £30,000; dividend of 6 per cent. on the ordinary shares, £21,000; preference dividend, £23,000; carried forward, £138,893.

Contracts Open.

St. Helens, I.W., December 9.—Cast-iron pipes, for the Urban District Council. Mr. C. Pursey, surveyor, High Park, Ryde, I.W.

Achmoun, Egypt, January 1.—Centrifugal pump, etc., for the Egyptian Ministry of the Interior. The Department of Overseas Trade. (Reference A.X. 10,518.)

Mullingar, December 1.—Cast-iron water mains, pumps, etc., for the Westmeath County Board of Health. Mr. P. H. McCarthy, consulting engineer, 26, Lower Leeson Street, Dublin. (Fee £10, returnable.)

Obituary.

Mr. J. W. Parker, A.M.Inst.T., who contributed regularly to this Journal articles on transport subjects, died recently at the age of 34 years.

Mr. Frederick Charles Kitson, who until his retirement two years ago was chairman of the Leeds Wheel & Axle Company, Limited, has died at his home at Headingley, aged 78.

The death occurred on November 21 of Mr. W. H. Hawthorne, senior director and chairman of the board of directors of the Cannon Iron Foundries, Limited, Deepfields, South Staffs. He was 69 years of age, and had been associated with the firm all his life.

Mr. Emile Garcke, chairman of the Brush Electrical Engineering Company, Limited, whose death occurred suddenly on November 14, at the age of 74, had long been prominent in connection with the development of electrical industries. Born in Germany, he became a naturalised British subject at the age of 24. He was a member of the Institution of Electrical Engineers, of the Institute of Transport, and of the Executive Committee of the Federation of British Industries. He was also President of the British Electrical Federation, a Vice-President of the British Electrical and Allied Manufacturers' Association, and a director of several electrical undertakings and investment companies.

Personal.

Mr. William Napier, who for many years has been a moulder in Falkirk foundries, has celebrated his golden wedding. Mr. and Mrs. Napier were recipients of many gifts.

Mr. George Scott, a foreman in the Cowlairs Locomotive Works of the L. & N.E. Railway Company, is retiring after 51 years' service, and has been entertained by the employees and received presentations to mark the occasion.

Wills.

Withers, T. J., of West Bromwich, for over 50 years associated with the Patent Shaft & Axletree Company, Limited, Wednesbury	£9,385

Reader's Inquiry.

We have received an inquiry for the names and addresses of manufacturers of cast-iron dryer smoke tubes. Can any of our readers supply the desired information?

Telephones: SHEFFIELD 22311 (3 lines) LONDON 1483 Central GLASGOW South 1580 WORKSOP 205 AMBERGATE 7 STOCKSBRIDGE 27 GALSTON 49

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Sir Robert Hadfield's advice!

Speaking to the Colonial Premiers and others when they visited Hadfield's Steel Foundry on November 7th, Sir Robert said:

"I appeal to all present to support British manufacturers in every possible way . . . . . We can do a great deal amongst ourselves by mutual help and co-operation. British Steelmakers can give you the best steel for every purpose, and in these days it pays to use none but the best.

What is true of the steel industry is equally true of other industries in this country, BEFORE YOU BUY FOREIGN PRODUCTS OR PLACE ORDERS ABROAD—MAKE SURE YOU CANNOT OBTAIN AT LEAST AS HIGH QUALITY AND GOOD VALUE IN THIS COUNTRY."

WILL YOU DO AS SIR ROBERT SAYS?

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TRIED, TRUSTED AND TRUE THROUGH SIXTEEN LONG YEARS. IS BRITISH THROUGHOUT

and is cheaper, better, handier and more reliable than any FOREIGN SAND.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Although now reduced to a minimum total of production, with fewer furnaces in blast than for years past, the Cleveland ironmasters are perhaps fortunate in one important respect, inasmuch that the output of pig-iron is going steadily into consumption, with a consequent absence of heavy stocks to carry as overhead charge. The position is, moreover, further complicated by keen competition from other producers at home and abroad. The Midlands makers recently reduced their prices by 2s. 6d., and, favoured by special railway rates, they are able to deliver pig-iron here at lower prices than the local producers are asking. Still more formidable is the competition from abroad. Belgian iron has been sold here at prices which Cleveland cannot even approach. As low as 47s. 6d. per ton f.o.b. Antwerp is stated to have been accepted, and the result is that foreign iron is still coming into the Tees. Notwithstanding these difficulties, the Cleveland ironmasters are able to carry on, and, moreover, they maintain their prices unchanged. On that point they are unwavering. Costs are too high to permit of price-cutting, except at a loss which they are not in a position to shoulder. Prices accordingly are unchanged, as follow:—No. 1 Cleveland foundry iron, 66s. per ton; No. 3 G.M.B., 63s. 6d.; No. 4 foundry iron, 62s. 6d.; No. 4 forge, 62s. per ton.

In the market for East Coast hematite, makers have been able by the limitation of production to stabilise prices and reduce stocks. There are, however, still substantial quantities of hematite to be liquidated. However, deliveries to the British works keep at a satisfactory level, and a few export orders continue to come along. Nominally prices are unchanged, with East Coast mixed numbers at 71s. per ton and No. 1 quality at 71s. 6d. On the North-West Coast, Bessemer mixed numbers are still quoted 70s. per ton at works.

LANCASHIRE.—The recent reduction in prices of foundry pig by the Midland furnace owners has, so far, had little effect in inducing buyers to extend purchases beyond immediate or urgent needs, while very few transactions are recorded except for early delivery. In the meantime, the current prices for Midland brands for local delivery are 69s. 6d. for Derbyshire and Staffordshire No. 3 and 68s. for Northamptonshire, with Scottish iron offered around 91s. per ton.

THE MIDLANDS.—In this area reports are slightly more favourable with regard to dealings in foundry pig, and most of the makers have received appreciably more orders of late than for some time past. Here and there consumers have contracted for supplies for the next two or three months, but this position is by no means general. Ironfounders are still badly placed for work and are chary of entering into forward commitments with the outlook so uncertain. The prevailing minimum zone prices are 67s. 6d. for Northants No. 3 and 71s. for North Staffordshire and Derbyshire No. 3, with Scotch brands quoted 93s. 6d. to 95s., delivered to local stations.

SCOTLAND.—There is no improvement in the demand for Scotch pig-iron. Most of the engineering founders have only a few men working, and even these are only employed intermittently. In other cases the foundries are only working alternate weeks. Unfortunately, there is still no sign of any change for the better. The price of Scotch pig-iron remains unchanged on the basis of 76s. 6d. for No. 3 foundry, f.o.t. furnaces.

Finished Iron.

This section of the Black Country industry continues in a very disappointing condition, and, while so little tonnage is available, price-cutting is general. From the local works crown bars are offered at between £10 and £10 5s., but if a good order was involved, it is quite certain that the former figure would be shaded somewhat, as crown bars from outside the district are offered at down to £9 15s. The marked-bar makers maintain without difficulty the figure of £12 10s. at works, and business remains fairly good for this grade of iron. No improvement is possible in connection with nut and bolt iron whilst foreign prices remain so low. French and Belgian No. 3 is being offered at £5 7s. 6d. to £5 10s., while local supplies are quoted at between £8 15s. and £9.

Steel.

Although still much below the normal standard of demand, business in the semi-finished steel department has been rather more active. Prices of Continental semi-finished steel have become firmer, and consumers have shown greater interest in the market. The British producers have also experienced a rather better demand. The improvement in the market, however, is more noticeable in the finished-steel department, in which there has been a fair amount of buying. Some of the export markets also have shown a greater inclination to buy. At Sheffield, the steel market is very dull, with business in acid and basic billets worse than it has been for a long while. The demand for wire rods is also weak. Throughout the market is being sharply affected by cheap imported material. Prices:—Siemens acid billets, £9 10s.; basic billets, soft, £6 10s.; medium, £7 12s. 6d.; hard, £8 2s. 6d. to £8 12s. 6d.; wire rods, acid, £12 5s. to £12 10s.; basic, soft, £8; medium hard, £9 15s. to £10; hard, £10 10s. to £11; steel hoops, £10. The tinplate market is still quiet, with the current quotation ruling 17s. basis for coke quality, net cash, f.o.b. South Wales ports.

Scrap.

In this class of foundry material business remains dull and disappointing, consumers on the North-East Coast and elsewhere using very small quantities of scrap at the present time. Tees-side quotations still rule about 50s. per ton for ordinary heavy cast iron, with machinery quality quoted 53s. 6d. per ton. In the Midlands, heavy cast-iron scrap is inactive, but the price continues at 51s. for ordinary and 53s. 6d. for machinery qualities, both delivered. In Scotland there is no change in the cast-iron scrap market, first-class machinery metal, suitable for foundries, being offered at around 60s. to 62s. 6d., ordinary cast 52s. 6d. to 55s.; steelworks cast iron 50s.; light cast iron 43s. 6d. to 45s., with firebars at 42s. 6d. and railway chairs at 57s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—The recent inflation of warrant copper prices received a check last week following the movements of the American market, where second hands were offered as low as 10·75 cents. At the close of the week, however, speculative manipulation had succeeded in restoring the price to £47, but at this level a net loss of £3 15s. on the week was shown. As a result of the recent scare, consumers, principally in America, have made purchases for about six months ahead, so that there is now little new buying to be expected.

Closing quotations :—

Cash.—Thursday, £45 8s. 9d. to £45 10s.; Friday, £46 5s. to £46 7s. 6d.; Monday, £47 15s. to £47 17s. 6d.; Tuesday, £47 5s. to £47 7s. 6d.; Wednesday, £47 10s. to £47 12s. 6d.

Three Months.—Thursday, £45 11s. 3d. to £45 12s. 6d.; Friday, £46 5s. to £46 7s. 6d.; Monday, £47 15s. to £47 17s. 6d.; Tuesday, £47 7s. 6d. to £47 10s.; Wednesday, £47 12s. 6d. to £47 15s.

Tin.—Market operations in standard tin during the past week have disclosed few outstanding features of interest, movements in values having been influenced to some extent by fluctuations in copper. Buying by consumers has not been on any considerable scale, and, generally speaking, the outlook is not very favourable, for production is on the increase again and demand lags behind.

Official closing prices :—

Cash.—Thursday, £116 to £116 5s.; Friday, £114 15s. to £114 17s. 6d.; Monday, £113 17s. 6d. to £114; Tuesday, £113 17s. 6d. to £114; Wednesday, £114 2s. 6d. to £114 5s.

Three Months.—Thursday, £117 5s. to £117 10s.; Friday, £116 2s. 6d. to £116 5s.; Monday, £114 17s. 6d. to £115; Tuesday, £115 5s. to £115 7s. 6d.; Wednesday, £115 7s. 6d. to £115 10s.

Spelter.—This market has been rather lifeless, and consumptive demand is at a low ebb except for a moderate inquiry for high-grade metal for next year's delivery. The tendency is uncertain, and a lead from the producers is awaited.

Daily fluctuations :—

Ordinary. — Thursday, £14 15s.; Friday, £14 12s. 6d.; Monday, £14 13s. 9d.; Tuesday, £14 7s. 6d.; Wednesday, £14 3s. 9d.

Lead.—After touching £16 the market reacted rapidly, but has since made up some of the lost ground and appears to be now fairly sound. Arrivals are rather heavy, and warehouse stocks are inclined to increase. Trade demand is moderate.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £16 1s. 3d.; Friday, £15 16s. 3d.; Monday, £15 18s. 9d.; Tuesday, £16 1s. 3d.; Wednesday, £16 1s. 3d.

Scottish Steel and Iron Merger.

JAMES DUNLOP AND DAVID COLVILLE & SONS.

Negotiations for the amalgamation of certain iron and steel and other interests of Messrs. David Colville & Sons, Limited, and Messrs. James Dunlop & Company, Limited, have been proceeding for some time. It is now announced that the directors of the two companies have reached a provisional agreement for the merger. The terms of the arrangement are contained in a circular issued to the shareholders of James Dunlop & Company, Limited. It has been provisionally agreed to form a new company, to be named Colvilles, Limited, to acquire as at January 1, 1931, the following assets:—From David Colville & Sons, Limited.—The Dalzell Steel & Iron Works, Motherwell; the Clydebridge Steelworks, Cambuslang; and the Glengarnock Iron and Steel Works, Glengarnock. From James Dunlop & Company, Limited.—The Clyde Ironworks, Tollcross; the Calderbank Steelworks, Airdrie; and the Clyde Coalfield and other lands, along with the Clyde and Calderbank Collieries.

The share capital of the new company will amount to £4,500,000, and will be allotted as fully paid to the vendor companies, as the consideration for the assets to be acquired, as follows:—

	David Colville.	James Dunlop.
1,650,000 first 7 per cent. cumulative preference shares of £1 each	£1,371,400	£278,600
920,000 second 7½ per cent. preference shares of £1 each (cumulative up to 5 per cent. after January 1, 1936)	£860,000	£60,000
1,930,000 ordinary shares of £1 each	£1,818,600	£111,400
	£4,050,000	£450,000

It is understood that David Colville & Sons, Limited, will nominate four directors to the new board, including the present chairman of the company, Mr. John Craig. The circular to the shareholders of James Dunlop & Company, Limited, states that the board of the new company will consist of seven directors, including Sir James Lithgow, Bt., Mr. Henry Lithgow and Mr. P. Baxter, who are directors of James Dunlop & Company.

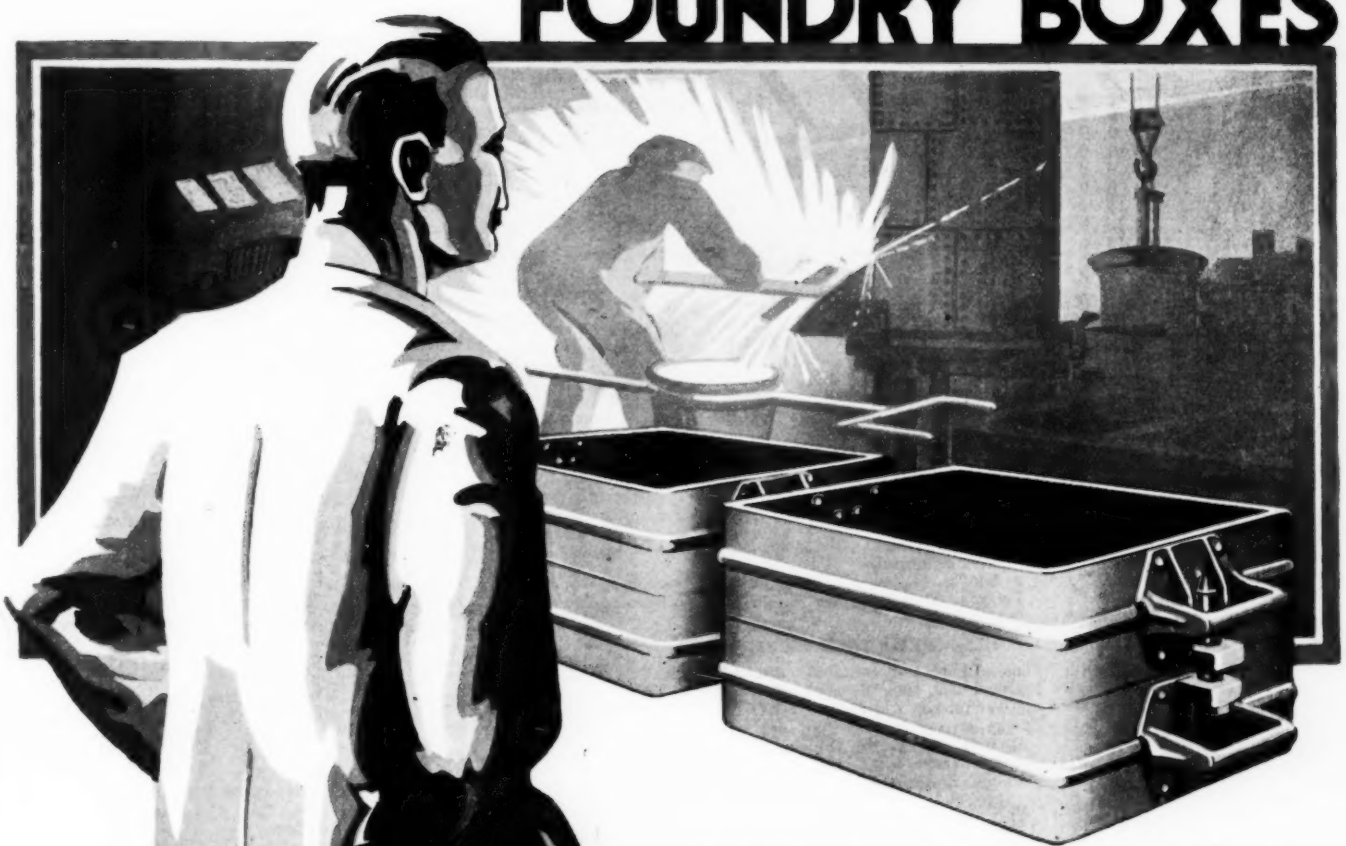
David Colville & Sons are to transfer to the new company their steelworks and blast furnaces, but are retaining all other assets, including their subsidiary companies, consisting of Archibald Russell, Limited, Smith & McLean, Limited, Clyde Alloy Steel Company, Limited, Fulwood Foundry Company, Limited, and Carnlough Lime Company, Limited.

The circular states that it is proposed to continue the existing company of James Dunlop & Company, Limited, as a company holding their allotment of the shares of the new company, and operating the Cardowan Colliery, which has now reached the producing stage and is developing satisfactorily. The completed cost of this colliery is expected to reach £480,000. The company will also hold floating assets to the net value of about £60,000. On the other hand, they will remain liable for loans and bank advances of approximately £430,000.

The shareholders of James Dunlop & Company, Limited, will meet on December 5 to consider resolutions to carry out the agreement. David Colville & Sons, Limited, are a private company, controlled by Messrs. Harland & Wolff, Limited.

A dressing for leather belts may be made from 2 lbs. of edible beef tallow and 1 lb. of cod-liver oil. The tallow is first melted and then the cod-liver oil added. This should be applied to the belt by a camel-hair brush.

FOUNDRY BOXES



...that speed up production for the Modern Foundry—

One of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX . . . . the result is speed and economy all round. Your moulders will put down more moulds per day because of the light and easy handling properties of these boxes.

You will be sure of producing accurate castings because STERLING BOXES maintain their accuracy permanently. Also your moulding costs will be halved—STERLING BOXES stand up to heavy service, anywhere.

Sterling

UP-TO-DATE

MOULDING BOX EQUIPMENT

Save their cost in a few months, and are obviously a sound investment for any foundry.

STERLING FOUNDRY SPECIALTIES LTD.,

WORKS— BEDFORD.

LONDON OFFICE:— 13, VICTORIA STREET, S.W.1.

GLASGOW - MANCHESTER - NEWCASTLE-ON-TYNE.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	47	10	0
Three months	47	12	6
Electrolytic	51	0	0
Tough	48	0	0
Best selected	48	10	0
Sheets	84	0	0
India	62	0	0
Wire bars	56	15	0
Do. November	56	15	0
Do. February	56	15	0
Ingot bars	56	15	0
H.C. wire rods	56	0	0
Off. av. cash, October	43	1	5 13/40
Do., 3 mths. October	43	0	8 37/40
Do., Sttlmnt., October	43	1	1 1/20
Do., Electre, October	46	6	6 9/20
Do., B.S., October	45	14	8 1/20
Do., wire bars, October	46	17	7 7/20
Solid drawn tubes			12d.
Brazed tubes			12d.
Wire			8d.

BRASS.

Solid drawn tubes	10½d.
Brazed tubes	11½d.
Rods, drawn	10d.
Rods, extd. or rlld.	6d.
Sheets to 10 w.g.	9d.
Wire	9d.
Rolled metal	8½d.
Yellow metal rods	6d.
Do. 4 × 4 Squares	6½d.
Do. 4 × 3 Sheets	6¾d.

TIN.

	£	s.	d.
Standard cash	114	2	6
Three months	115	7	6
English	115	5	0
Bars	117	0	0
Straits	118	15	0
Australian	117	7	6
Eastern	119	17	6
Banca	118	7	6
Off. av. cash, October	117	11	1 1/40
Do., 3 mths., October	119	0	5 5/40
Do., Sttlmt., October	117	11	1 1/20

SPELTER.

	£	s.	d.
Ordinary	14	3	9
Remelted	12	12	6
Hard	11	0	0
Electro 99.9	16	15	0
English	14	15	0
India	12	0	0
Zinc dust	20	0	0
Zinc ashes	3	10	0
Off. aver., October	14	13	9 1/20
Aver., spot, October	14	8	10 3/40

LEAD.

	£	s.	d.
Soft foreign ppt.	16	1	3
English	17	10	0
Off. average, October	15	14	2 5/40
Average spot, October	15	14	11 3/20

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	0	0
Do. V.M. ex-whf.	25	0	0
Rods	28	0	0
Boiler plates	21	0	0
Battery plates	21	0	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	25	0	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£11 10 0
75%	£18 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	11½d. lb.
Ferro-phosphorus, 20/25%	£15 17 6
Ferro-tungsten—	
80/85%	2/3 lb.
Tungsten metal powder—	
98/99%	2/6 lb.
Ferro-chrome—	
2/4% car.	£30 10 0
4/6% car.	£23 5 0
6/8% car.	£22 10 0
8/10% car.	£22 2 6
Ferro-chrome—	
Max. 2% car.	£32 17 6
Max. 1% car.	£37 15 0
Max. 0.70% car.	£41 0 0
70%, carbon-free	11d. lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/7 lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 0 0 to £11 10 0
76/80% packed	£12 0 0 to £12 15 0
76/80% export	£10 10 0 to £11 0 0
Metallic manganese—	
94/96% carbonless	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 2
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.		£	s.	d.
Heavy steel					2	5	0
Bundled steel and shrngs.	1	18	0	to	2	0	0
Mixed iron and steel	1	17	6	to	2	0	0
Heavy cast iron					2	7	6
Good machinery for foundries					2	10	0
Cleveland—							
Heavy steel					2	6	0
Steel turnings					1	15	0
Cast-iron borings					1	10	0
Heavy forge					3	2	6
W.I. piling scrap					2	17	6
Cast-iron scrap	2	10	0	to	2	13	6
Midlands—							
Ord. cast-iron scrap					2	5	0
Heavy wrought					2	15	0
Steel turnings					1	0	0
Scotland—							
Heavy steel					2	10	0
Ordinary cast iron					2	13	0
Engineers' turnings					1	15	0
Cast-iron borings					1	15	0
Wrought-iron piling					3	3	6
Heavy machinery					3	0	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	40	0	0
Brass	30	0	0
Lead (less usual draft)	14	0	0
Tea lead	10	10	0
Zinc	8	0	0
New aluminium cuttings	50	0	0
Braziery copper	37	0	0
Gunmetal	39	0	0
Hollow pewter	80	0	0
Shaped black pewter	60	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	66/-
Foundry No. 3	63/6
Foundry No. 4	62/6
Forge No. 4	62/-
Hematite No. 1	71/6
Hematite M/Nos.	71/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	78/6
„ d/d Birm.	88/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	66/-
„ No. 3 fdry.*	71/-
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	62/6
„ fdry. No. 3*	67/6
Derbyshire forge*	66/-
„ fdry. No. 3*	71/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	79/-
„ No. 3	76/6
Hem. M/Nos.	77/-
Sheffield (d/d district)—	
Derby forge	61/-
„ fdry. No. 3	66/-
Lincs. forge	—
„ fdry. No. 3	67/6
E.C. hematite	83/6
W.C. hematite	86/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	64/6
„ fdry. No. 3	69/6
Staffs foundry No. 3	69/6
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	91/-
Glengarnock, No. 3	—
Eglinton, No. 3	91/-
Gartsherrie, No. 3	91/-
Monkland, No. 3	91/-
Shotts, No. 3	91/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	10	0	0	to	10	15	0
Nut and bolt iron	8	15	0	to	9	0	0
Hoops	10	15	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip	10	15	0	to	12	0	0
Bolts and nuts, ½ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	15	0	to	8	17	6
Boiler plts.	9	7	6	to	10	5	0
Chequer plts.					10	12	6
Angles					8	7	6
Tees					9	7	6
Joists					8	10	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ½ in. (Untested)					7	12	6

and upwards

Flats—8 in. wide and over	£8 12 6
„ under 8 in. and over 5 in.	£8 17 6
Rails, heavy	£8 10 0
Fishplates	£12 0 0
Hoops (Staffs)	£9 5 0 to £9 10 0
Black sheets, 24g.	£8 15 0 to £9 15 0
Galv.cor.shts., 24g.	£11 5 0
Galv fencing wire, 8g. plain	£12 0 0
Billets, soft	£5 12 6 to £6 5 0
Billets, hard	£7 10 0 & up.
Sheet bars	£5 0 0 to £5 12 6
Tin bars	£5 0 0 to £5 12 6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/1
Sheet to 10 w.g.	1/1½
Wire	1/2
Rods	1/1½
Tubes	1/6
Castings	1/1

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
3/0 to 10 G.	1/5½ to 2/0½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	18.76
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	14.00
Basic	18.76
Bessemer	19.26
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80%	94.00
O.-h. rails, h'y, at mill	43.00
Billets	31.00
Sheet bars	31.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Skelp, sheared steel	1.70
Steel hoops	1.95
Sheets, black, No. 24	2.45
Sheets, galv., No. 24	2.95
Sheets, blue an'l'd, No. 13	2.05
Wire nails	1.95
Plain wire	2.30
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	25/- to 27/6
„ furnace	16/- to 18/-
Durham and Northumberland—	
„ foundry	14/6 to 15/-
„ furnace	14/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box		16/6
„	28×20 „		33/-
„	20×10 „		—
„	18¾×14 „		—
C.W.	20×14 „		15/6
„	28×20 „		31/-
„	20×10 „		—
„	18¾×14 „		—
Terneplates	28×20		31/- per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to £7	10 0
Bars, hammered, basis	£17	10	0	to £18	10 0
Bars and nail-rods, rolled, basis	£15	17	6	to £16	15 0
Blooms	£10	0	0	to £12	0 0
Keg steel	£32	0	0	to £33	0 0
Faggot steel	£20	0	0	to £24	0 0
Bars and rods dead soft, steel	£11	0	0	to £14	0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ¼ in. up to 6 in.

	Tubes.	Fittings.
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov.	20 ..	45	8	9	dec.	11/3
,,	21 ..	46	5	0	inc.	16/3
,,	24 ..	47	15	0	,,	30/–
,,	25 ..	47	5	0	dec.	10/–
,,	26 ..	47	10	0	inc.	5/–

Electrolytic Copper.

		£	s.	d.		
Nov.	20 ..	49	0	0	dec.	20/–
,,	21 ..	52	0	0	inc.	60/–
,,	24 ..	52	0	0	No change	
,,	25 ..	52	0	0	,, ,,	
,,	26 ..	51	0	0	dec.	20/–

Standard Tin (cash).

		£	s.	d.		
Nov.	20 ..	116	0	0	inc.	55/–
,,	21 ..	114	15	0	dec.	25/–
,,	24 ..	113	17	6	,,	17/6
,,	25 ..	113	17	6	No change	
,,	26 ..	114	2	6	inc.	5/–

Tin (English ingots).

		£	s.	d.		
Nov.	20 ..	117	0	0	inc.	55/–
,,	21 ..	115	15	0	dec.	25/–
,,	24 ..	115	0	0	,,	15/–
,,	25 ..	115	0	0	No change	
,,	26 ..	115	5	0	inc.	5/–

Zinc Sheets (English).

		£	s.	d.		
Nov.	20 ..	24	0	0	No change	
,,	21 ..	24	0	0	,, ,,	
,,	24 ..	24	0	0	,, ,,	
,,	25 ..	24	0	0	,, ,,	
,,	26 ..	24	0	0	,, ,,	

Spelter (ordinary).

		£	s.	d.		
Nov.	20 ..	14	15	0	inc.	3/9
,,	21 ..	14	12	6	dec.	2/6
,,	24 ..	14	13	9	inc.	1/3
,,	25 ..	14	7	6	dec.	6/3
,,	26 ..	14	3	9	,,	3/9

Lead (English).

		£	s.	d.	
Nov.	20 ..	17	10	0	No change
,,	21 ..	17	5	0	dec. 5/–
,,	24 ..	17	5	0	No change
,,	25 ..	17	10	0	inc. 5/–
,,	26 ..	17	10	0	No change

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	2 3 0	2 3 0	2 2 6	2 2 6	2 2 6	2 4 0	2 3 6	2 4 0	2 5 0	2 5 6	2 6 6	2 6 6	2 3 11½
1896	2 5 6	2 6 0	2 6 0	2 6 0	2 6 0	2 5 6	2 5 0	2 5 0	2 5 0	2 6 0	2 7 0	2 8 6	2 5 11½
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 5 0	2 5 0	2 5 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	4 0 0	3 6 2½	
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 8 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 0	3 10 1½	—	—

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